SCIENCE

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THE COMMON AIMS OF SCIENCE AND HUMANITY[1]

UNDER the influence of the diversity of pursuits imposed upon us by the conditions of modern life, different groups of the community—men of business, men of science, philosophers or artists—have acquired detached and sometimes opposing interests. Each group, impressed by the importance of its own domain in the life of the nation, and focusing its vision on small differences and temporary rivalries, was in danger of losing the sense of mutual dependence. But in the shadow of a great catastrophe it has been brought home to us that the clash of interests is superficial, and the slender thread of union which remained has grown into a solid bond. What is the fiber from which the bond is twined? Patriotism may express its outward manifestation, but its staple is the mental relationship which remains continuous and dominant even in normal times, when each of us may peacefully go to earn his living and enjoy the course of his intellectual life.

Outwardly the community is divided into heterogeneous elements with mental attitudes cast in different moulds, and proceeding along separate roads by differing methods to different ideals. Yet as we eliminate the superficial, and regard only the deep-seated emotions which control our thoughts and actions, the differences vanish, and the unity of purpose and sentiment emerges more and more strongly. Mind and character, no doubt, group themselves into a number of types, but the cleavage runs

[1] Address of the President of the British Association for the Advancement of Science, Manchester, 1915.

across, and not along, the separating line of professions.

Were it otherwise, the British Association could not perform one of its most important functions—a function not, indeed, originally contemplated, but resulting indirectly from the wise and democratic provisions in its constitution, which enabled it to adapt itself to the changing needs of the time. Our founders primarily considered the interests of scientific men; their outlook was restricted and exclusive, both as regards range of subject and membership. In the words of Sir David Brewster, who gave the first impulse to its formation, it was to be "an Association of our nobility, clergy, gentry and philosophers."

The meetings were intended to promote personal intercourse, to organize research, to advocate reform of the laws hindering research, and to improve the status of scientific men. The right of membership was confined to those who already belonged to some learned society, and William Whewell, one of the principal supporters of the movement, even suggested that only authors of memoirs published by a learned society should be admitted.[2] He emphasized this proposal by the recommendation[3] "in some way to avoid the crowd of lay members whose names stand on the List of the Royal Society." The reform of the Patent Laws and the introduction of an International Copyright were suggested as subjects suitable for discussion, not apparently from the point of view of general advantage, but merely in the interests of one section of the community.

Whatever the objects of the founders of the association may have been, it is obvious that questions of public importance could not be permanently excluded from meetings the success of which depended on the interest stimulated in the community. The statistical section, which owed its origin to the visit, at the first Oxford meeting (1836), of Quetelet, the Belgian astronomer and economist, was the first to assert itself by engaging in a discussion of the Poor Laws. Whewell deeply resented this violation of academic neutrality: "it was impossible," he wrote, "to listen to the Proceedings of the Statistical Section on Friday without perceiving that they involved exactly what it was most necessary and most desired to exclude from our Proceedings,"[4] and again: "Who would propose (I put it to Chalmers, and he allowed the proposal to be intolerable) an ambulatory body, composed partly of men of reputation and partly of a miscellaneous crowd, to go round year by year from town to town and at each place to discuss the most inflammatory and agitating questions of the day?"[5]

Fortunately for our association, this narrow-minded attitude did not prevail, and our records show that while not avoiding controversial and even inflammatory subjects, we have been able to exercise a powerful influence on the progress of science. The establishment of electric units, universally accepted throughout the world, originated in the work of one of our committees; the efforts which led to the foundation of the National Physical Laboratory, one of the most efficient and beneficial organizations in the country, received its first impulses from us; and the organization of the first world service for the systematic investigation of earth tremors was established by

[2] Others were allowed to join on recommendation by the General Committee. It was only in 1906 that this restriction, which had become obsolete, was removed.

[3] Whewell's "Writings and Letters," Vol. II., p. 128.

[4] *Loc. cit.*, p. 289.

[5] It is much to be desired that the documents relating to the early history of the British Association should be published in a collected form.

the late Dr. Milne, working through one of our committees.

The success of these enterprises alone is sufficient to show that we are not merely a body promoting social intercourse between men of science and the rest of the community. Nevertheless, it may be admitted that our efforts have been spasmodic, and the time has arrived to consider whether it may be possible to secure not only a greater continuity in our work but also its better coordination with that of other scientific organizations. The present juncture affords the opportunity, and the changed conditions, which in the near future will affect all our institutions, render it indeed incumbent upon us once more to adapt ourselves to the needs of the times. Proposals for a move in that direction have already been made, and will no doubt be carefully considered by the council. In the meantime, I may draw your attention to the important discussions arranged for by our Economic Section, which alone will justify the decision of the council not to suspend the meeting this year.

It must not be supposed that, even in the early days of the association, Whewell's ideas of its functions were universally accepted. It is pleasant to contrast the lamentations of the omniscient professor of mineralogy with the weightier opinion of the distinguished mathematician who then held Newton's chair at Cambridge. At the concluding session of the second meeting of the association, Babbage expressed the hope "that in the selection of the places at which the annual meetings were to be held, attention should be paid to the object of bringing theoretical science in contact with the practical knowledge on which the wealth of the country depends." "I was myself," he said, "particularly anxious for this, owing as I do a debt of gratitude for the valuable information which I have received in many of the manufacturing districts, where I have learned to appreciate still more highly than before the value of those speculative pursuits which we follow in our academical labors. I was one of those who thought at first that we ought to adjourn for our next meeting to some large manufacturing town; but I am now satisfied that the arrangement which has been made will be best adapted to the present state of the association. When, however, it shall be completely consolidated I trust we may be enabled to cultivate with the commercial interests of the country that close acquaintance which I am confident will be highly advantageous to our more abstract pursuits."

Since then, as we all know, our most successful meetings have been held in manufacturing centers; but it is important to note that, while Babbage laid stress on the benefit which would accrue to pure science by being brought into contact with practical life, scientific men of the present day have more and more insisted on the services they, on their part, are able to render to the industries. The idealistic motive has thus given way to the materialistic purpose. Both aspects are perhaps equally important, but it is necessary to insist, at the present time, that the utilitarian drum can be beaten too loudly. There is more than one point of contact between different activities of the human mind, such as find expression in scientific pursuits or commercial enterprises, and it is wrong to base the advantages to be derived from their mutual influence solely, or even mainly, on the ground of material benefits.

I need not press this point in a city which has given many proofs that a business community may be prompted by higher motives than those which affect their pockets. It was not for utilitarian objects that repeated efforts were made since the year 1640 to establish a University in Man-

chester; it was not for reasons of material gain that the Royal Institution and Owens College were founded; nor was it because they increased the wealth of the district that the place of honor in our Town Hall has been given to Dalton and Joule.

When we glance at the various occupations of the working parts of a nation, comprising the student who accumulates or extends knowledge, the engineer who applies that knowledge, the geologist or agriculturist who discloses the store of wealth hidden in the soil, the commercial man who distributes that wealth, it seems as if we ought to be able to name the qualities of intellect and temperament which in each pursuit are most needed to carry out the work successfully. But on trying to define these qualities we soon discover the formidable nature of the task. Reasoning power, inventive power, and sound balance of judgment are essential attributes in all cases, and the problem is reduced to the question whether there are different varieties of the attributes which can be assigned to the different occupations.

Among all subjects mathematics is perhaps the one that appears most definitely to require a special and uncommon faculty. Yet, Poincaré—himself one of the clearest thinkers and most brilliant exponents of the subject—almost failed when he attempted to fix the distinguishing intellectual quality of the mathematician. Starting from the incontrovertible proposition that there is only one kind of correct reasoning, which is logical reasoning, he raises the question why it is that everybody who is capable of reasoning correctly is not also a mathematician, and he is led to the conclusion that the characterizing feature is a peculiar type of memory. It is not a better memory, for some mathematicians are very forgetful, and many of them can not add a column of figures correctly; but it is a memory which fixes the order in which the successive steps of reasoning follow each other without necessarily retaining the details of the individual steps. This Poincaré illustrates by contrasting the memory of a chess-player with that of a mathematician. "When I play chess," he says, "I reason out correctly that if I were to make a certain move, I should expose myself to a certain danger. I should, therefore, consider a number of other moves, and, after rejecting each of them in turn, I should end by making the one which I first contemplated and dismissed, having forgotten in the meantime the ground on which I had abandoned it." "Why, then," he continues, "does my memory not fail me in a difficult mathematical reasoning in which the majority of chess-players would be entirely lost? It is because a mathematical demonstration is not a juxtaposition of syllogisms, but consists of syllogisms placed in a certain order; and the order in which its elements are placed is much more important than the elements themselves. If I have this intuition—so to speak—of the order, so as to perceive at one glance the whole of the reasoning, I need not fear to forget its elements: each of these will take its right place of its own accord without making any call on my memory."[6]

Poincaré next discusses the nature of the intellectual gift distinguishing those who can enrich knowledge with new and fertile ideas of discovery. Mathematical invention, according to him, does not consist in forming new combinations of known mathematical entities, because the number of combinations one could form are infinite, and most of them would possess no interest whatever. Inventing consists, on the contrary, in excluding useless combinations, and therefore: "To invent is to select—to choose." . . . "The expression 'choose'

[6] "Science et Méthode," pp. 46 and 47.

perhaps requires qualifying, because it recalls a buyer to whom one offers a large number of samples which he examines before making his choice. In our case the samples would be so numerous that a lifetime would not suffice to complete the examination. That is not the way things are done. The sterile combinations never present themselves to the mind of the inventor, and even those which momentarily enter his consciousness, only to be rejected, partake something of the character of useful combinations. The inventor is therefore to be compared with an examiner who has only to deal with candidates who have already passed a previous test of competence."

All those who have attempted to add something to knowledge must recognize that there is a profound truth in these remarks. New ideas may float across our consciousness, but, selecting the wrong ones for more detailed study, we waste our time fruitlessly. We are bewildered by the multitude of roads which open out before us, and, like Poincaré when he tries to play chess, lose the game because we make the wrong move. Do we not all remember how, after the announcement of a new fact or generalization, there are always many who claim to have had, and perhaps vaguely expressed, the same idea? They put it down to bad luck that they have not pursued it, but they have failed precisely in what, according to Poincaré, is the essence of inventive power. It may be bad luck not to have had a good idea, but to have had it and failed to appreciate its importance is downright incapacity.

An objection may be raised that before a selection can be made the ideas themselves must appear, and that, even should they arrive in sufficient numbers, the right one may not be among them. It may even be argued that Poincaré gives his case away by saying that "the sterile combinations do not even present themselves to the mind of the inventor," putting into a negative form what may be the essence of the matter. Moreover, a fertile mind like that of Poincaré would be apt to place too low a value on his own exceptional gifts. Nevertheless, if Poincaré's more detailed exposition be read attentively, and more especially the description of how the discoveries which made him famous among mathematicians originated in his mind, it will be found that his judgment is well considered and should not be lightly set aside. New ideas seldom are born out of nothing. They most frequently are based on analogies, or the recollection of a sequence of thoughts suggested by a different branch of the subject, or perhaps by a different subject altogether. It is here that the memory comes in, which is not a memory of detail, but a memory of premises with their conclusions, detached from the particular case to which they were originally applied. Before we pronounce an adverse opinion on Poincaré's judgment, we must investigate what constitutes novelty in a new idea, but the subject is too vast to be dealt with here, nor can I attempt to discuss whether an essential distinction exists between mathematical invention and that more practical form of invention with which, for instance, the engineer has to deal.

If Poincaré, by this introspective analysis of his own powers, has dimmed the aureole which, in the eyes of the public, surrounds the mathematician's head, he removes it altogether by his definition of mathematics. According to him, "mathematics is the art of calling two different things by the same name." It would take me too far were I to try to explain the deep truth expressed in this apparently flippant form: physicists, at any rate, will remember the revolution created in the fundamental outlook of science by the application of the

term "energy" to the two quite distinct conceptions involved in its subdivisions into potential and kinetic energy.

Enough has been said to show that the peculiar powers necessary for the study of one of the most abstract branches of knowledge may be expressed in terms which bring them down to the level at which comparison with other subjects is possible. Applying the same reasoning to other occupations, the same conclusion is inevitable. The commercial man, the politician and the artist must all possess the type of memory best suited to concentrate in the field of mental vision their own experiences as well as what they have learned from the experience of others; and, further, they must have the power of selecting out of a multitude of possible lines of action the one that leads to success; it is this power which Poincaré calls the inventive faculty.

The argument must not be pushed too far, as it would be absurd to affirm that all differences in the capability of dealing successfully with the peculiar problems that occur in the various professions may be reduced to peculiarities of memory. I do not even wish to assert that Poincaré's conclusions should be accepted without qualification in the special case discussed by him. What is essential, to my mind, is to treat the question seriously, and to dismiss the vague generalities which, by drawing an artificial barrier between different groups of professions, try to cure real or imaginary defects through plausible though quite illusory remedies. All these recommendations are based on the fallacy that special gifts are associated with different occupations. Sometimes we are recommended to hand over the affairs of the nation to men of business; sometimes we are told that salvation can only be found in scientific methods—what is a man of business, and what is a scientific method? If you define a man of business to be one capable of managing large and complicated transactions, the inference becomes self-evident; but if it be asserted that only the specialized training in commercial transactions can develop the requisite faculties, the only proof of the claim that could be valid would be the one that would show that the great majority of successful statesmen, or political leaders, owed their success to their commercial experience. On the other hand, every method that leads to a correct result must be called a scientific method, and what requires substantiating is that scientific training is better than other training for discovering the correct method. This proof, as well as the other, has not been, and, I think, can not be, given. When, therefore, one man calls for the conduct of affairs "on business lines" and the other clamors for scientific methods, they either want the same thing or they talk nonsense. The weak point of these assertions contrasting different classes of human efforts is that each class selects its own strongest men for comparison with the weakest on the other side.

The most fatal distinction that can be made is the one which brings men of theory into opposition to men of practise, without regard to the obvious truth that nothing of value is ever done which does not involve both theory and practise; while theory is sometimes overbearing and irritating, there are among those who jeer at it some to whom Disraeli's definition applies: the practical man is the man who practises the errors of his forefathers. With refined cruelty Nemesis infects us with the disease most nearly akin to that which it pleases us to detect in others. It is the most dogmatic of dogmatics who tirades against dogma, and only the most hopeless of theorists can declare that a thing may be right in theory and wrong in practise.

Why does a theory ever fail, though it

may be sound in reasoning? It can only do so because every problem involves a much larger number of conditions than those which the investigator can take into account. He therefore rejects those which he believes to be unessential, and if his judgment is at fault he goes wrong. But the practical man will often fail for the same reason. When not supported by theoretical knowledge he generalizes the result of an observation or experiment, applying it to cases where the result is determined by an altogether different set of conditions. To be infallible the theorist would have to take account of an infinite number of circumstances, and his calculations would become unmanageable, while the experimenter would have to perform an infinite number of experiments, and both would only be able to draw correct conclusions after an infinite lapse of time. They have to trust their intuition in selecting what can be omitted with impunity, and, if they fail, it is mainly due to the same defect of judgment. And so it is in all professions: failure results from the omission of essential considerations which change the venue of the problem.

Though theory and practise can only come into opposition when one of them is at fault, there is undoubtedly a contrast in character and temperament between those who incline more towards the one and those who prefer the other aspect: some like a solitary life at the desk, while others enjoy being brought into contact with their fellows. There have at all times been men predestined by nature to be leaders, and leadership is required in all branches of knowledge—the theoretical as well as the more active pursuits; but we must guard against accepting a man's estimate of his own power to convert his thoughts into acts. In the ordinary affairs of life a man who calls himself a man of action is frequently only one who can not give any reasons for his actions. To claim that title justly a man must act deliberately, have confidence in his own judgment, sufficient tenacity of purpose to carry it through, and sufficient courage to run the unavoidable risks of possible failure. These risks may be trivial or they may be all-important. They may affect the reputation of one unit of creation or involve the whole life of a nation, and according to the greatness of the issue we shall honor the man who, having taken the risk, succeeds. But whether the scale be microscopic or interstellar, the essence of the faculty of blending theory and practise is the same, and both men of books and men of action are to be found in the philosopher's study and the laboratory, as well as in the workshop or on the battlefield. Modern science began, not at the date of this or that discovery, but on the day that Galileo decided to publish his Dialogues in the language of his nation. This was a deliberate act destined to change the whole aspect of science which, ceasing to be the occupation of a privileged class, became the property of the community. Can you, therefore, deny the claim of being a man of action to Galileo, can you deny it to Pasteur, Kelvin, Lister, and a host of others? There are, no doubt, philosophers who can not manage even their own affairs, and whom it would be correct to call pure theorists, but that proves nothing, because their defect makes them worse philosophers as well as worse citizens.

In his Presidential Address, delivered to this association in 1899, Sir Michael Foster summarized the essential features of the scientific mind. Above all other things he considered that its nature should be such as to vibrate in unison with what it is in search of; further, it must possess alertness, and finally moral courage. Yet after enumerating these qualities, he arrives at the same

result which I have tried to place before you, that there are no special peculiarities inherent in the scientific mind, and he expresses this conclusion in the following words:

> But, I hear some one say, these qualities are not the peculiar attributes of the man of science, they may be recognized as belonging to almost everyone who has commanded or deserved success, whatever may have been his walk in life. That is so. That is exactly what I would desire to insist, that the men of science have no peculiar virtues, no special powers. They are ordinary men, their characters are common, even commonplace. Science, as Huxley said, is organized common-sense, and men of science are common men drilled in the ways of common-sense.

This saying of Huxley's has been repeated so often that one almost wishes it were true, but unfortunately I can not find a definition of common-sense that fits the phrase. Sometimes the word is used as if it were identical with *uncommon* sense, sometimes as if it were the same thing as common *nonsense*. Often it means untrained intelligence, and in its best aspect it is, I think, that faculty which recognizes that the obvious solution of a problem is frequently the right one. When, for instance, I see, during a total solar eclipse, red flames shooting out from the edge of the sun, the obvious explanation is that these are real phenomena caused by masses of glowing vapors ejected from the sun; and when a learned friend tells me that all this is an optical illusion due to anomalous refraction, I object on the ground that the explanation violates my common-sense. He replies by giving me the reasons which have led him to his conclusions, and, though I still believe that I am right, I have to meet him with a more substantial reply than an appeal to my own convictions. Against a solid argument common-sense has no power and must remain a useful but fallible guide which both leads and misleads all classes of the community alike.[7]

If we must avoid assuming special intellectual qualities when we speak of groups of men within one country, we ought to be doubly careful not to do so without good reason in comparing different nations. So-called national characteristics are in many cases matters of education and training; and, if I select one as an example, it is because it figures so largely in public discussions at the present moment. I refer to that expedient for combining individual efforts which goes by the name of organization. An efficient organization requires a head that directs and a body that obeys; it works mainly through discipline, which is its most essential attribute. Every institution, every factor, every business establishment is a complicated organism, and no country ever came to prominence in any walk of life unless it possessed the ability to provide for the efficient working of such organisms. To say that a nation which has acquired and maintained an empire, and which conducts a large trade in every part of the world, is deficient in organizing power is therefore an absurdity. Much of the current self-depreciation in this respect is due to the confusion of what constitutes a true organization with that modification of it which to a great extent casts aside discipline and substitutes cooperation. Though much may be accomplished by cooperation, it is full of danger in an emergency, for it can only work if it be loyally adhered to; otherwise it resembles a six-cylinder motor in which every sparking-plug is allowed to fix its own time of firing. Things go well so long as the plugs agree; but there is nearly always one among them that persists in taking an independent course and, when the machine stops, complains that the

[7] Since writing the above, I find on reading Professor J. A. Thomson's "Introduction to Science" a similar criticism of Huxley's dictum. Professor Thomson's general conclusions are not, however, in agreement with those here advocated.

driver is inefficient. The cry for organization, justifiable as it no doubt often is, resolves itself, therefore, into a cry for increased discipline, by which I do not mean the discipline enforced at the point of the bayonet, but that accepted by the individual who voluntarily subordinates his personal convictions to the will of a properly constituted authority. This discipline is not an inborn quality which belongs more to one nation than to another; it is acquired by education and training. In an emergency it is essential to success, but if it be made the guiding principle of a nation's activity, it carries dangers with it which are greater than the benefits conferred by the increased facility for advance in some directions.

If there be no fundamental difference in the mental qualifications which lead to success in our different occupations, there is also none in the ideals which move us in childhood, maintain us through the difficulties of our manhood, and give us peace in old age. I am not speaking now of those ideals which may simultaneously incite a whole nation to combined action through religious fervor or ambition of power, but I am speaking of those more individual ideals which make us choose our professions and give us pleasure in the performance of our duties.

Why does a scientific man find satisfaction in studying nature? Let me once more quote Poincaré:[8]

> The student does not study Nature because that study is useful, but because it gives him pleasure, and it gives him pleasure because Nature is beautiful; if it were not beautiful it would not be worth knowing and life would not be worth living. I am not speaking, be it understood, of the beauty of its outward appearance—not that I despise it, far from it, but it has nothing to do with science: I mean that more intimate beauty which depends on the harmony in the order of the component parts of Nature. This is the beauty which a pure intelligence can appreciate and which gives substance and form to the scintillating impressions that charm our senses. Without this intellectual support the beauty of the fugitive dreams inspired by sensual impressions could only be imperfect, because it would be indecisive and always vanishing. It is this intellectual and self-sufficing beauty, perhaps more than the future welfare of humanity, that impels the scientific man to condemn himself to long and tedious studies. And the same search for the sense of harmony in the world leads us to select the facts which can most suitably enhance it, just as the artist chooses among the features of his model those that make the portrait and give it character and life. There need be no fear that this instinctive and unconscious motive should tempt the man of science away from the truth, for the real world is far more beautiful than any vision of his dreams. The greatest artists that ever lived—the Greeks—constructed a heaven; yet how paltry that heaven is compared to ours! And it is because simplicity and grandeur are beautiful that we select by preference the simplest and grandest facts, and find our highest pleasure, sometimes in following the gigantic orbits of the stars, sometimes in the microscopic study of that minuteness which also is a grandeur, and sometimes in piercing the secrets of geological times which attract us because they are remote. And we see that the cult of the beautiful guides us to the same goal as the study of the useful.
>
> Whence comes this harmony? Is it that things that appear to us as beautiful are simply those which adapt themselves best to our intelligence, and are therefore the tools which that intelligence handles most easily; or is it all the play of evolution and natural selection? In that case, those races only survived whose ideals best conformed with their interests, and while all nations pursued their ideals without regard to consequences, some were led to perdition and others achieved an empire. One is tempted to believe that such has been the course of history, and that the Greeks triumphed over the barbarians, and Europe, inheritor of Greek thought, rules the world, because the savages cared only for the sensual enjoyment of garish colors and the blatant noise of the drum, while the Greeks loved the intellectual beauty which is hidden beneath the visible beauty. It is that higher beauty which produces a clear and strong intelligence.

If the mathematician's imagination is fired by the beauty and symmetry of his

[8] *Loc. cit.*, p. 15.

methods, if the moving spring of his action is identical with that of the artist, how much truer is this of the man of science who tries by well-designed experiments to reveal the hidden harmonies of nature? Nor would it be difficult, I think, to trace the gratification inherent in the successful accomplishments of other intellectual pursuits to the same source.

Though Poincaré was, I believe, the first to lay stress on the connection between the search for the beautiful and the achievement of the useful, the esthetic value of the study of science had previously been pointed out, and well illustrated, by Karl Pearson in his "Grammar of Science." As expressed by him: "it is this continual gratification of the esthetic judgment which is one of the chief delights of pure science." Before we advance, however, any special claim for the pursuit of science based on these considerations, we must pause to think whether they do not equally apply to other studies or occupations. For this purpose, the nature of the esthetic enjoyment involved must be remembered. We do not mean by it, the pleasure we feel in the mere contemplation of an impressive landscape or natural beauty, but it resembles more the enjoyment experienced on looking at a picture where, apart from the sensual pleasure, we are affected by the relation between the result of the representation and that which is represented. The picture, quite apart from what it may be trying to imitate, has a certain beauty due to its contrast of colors or well-balanced arrangement. We have in one case a number of pigments covering a space of two dimensions, and in the other the natural object in three dimensions made up of entirely different materials and showing an infinite variety of detail and appearance. By itself alone either a mere photographic representation or a geometrical arrangement of color and line, leaves most of us cold; though both have their own particular beauty, the art consists in bringing them into connection. Bearing in mind the esthetic value of the relationship of the work of our brain or hand to external facts or appearances, it might easily be shown that what has been said of science equally applies to other studies, such as history or literature. We may even go further, and say that any occupation whatever, from which we can derive an intellectual pleasure, must possess to a greater or smaller degree the elements of combining the useful with the beautiful.

In order to trace in detail the part played by purely emotional instincts in directing the course of our lives, we should have to study the causes which influence a child, free to select his future profession. Having eliminated secondary effects, such as early associations, or the personal influence of an inspiring teacher, we should probably be brought to a standstill by the dearth of material at our disposal, or led into error by taking our own individual recollections as typical. Nevertheless it is only through the record of each man's experience that we may hope to arrive at a result. If every man who has reached a certain recognized position in his own subject—it need not be preeminence—would write down his own recollections of what led him to make the choice of his profession, we might hope to obtain facts on which a useful psychological study might be based. Scientific men as a class are not modest, but they share with other classes the reluctance to speak of their early life, owing to a certain shyness to disclose early ambitions which have not been realized. It requires courage to overcome that shyness, but I think that we need feel no shame in revealing the dreams of our childhood and holding fast to them despite the bondage of our

weakness, despite the strife ending so often in defeat, despite all the obstacles which the struggle for existence has placed in our path. In some form they should persist throughout our lives and sustain us in our old age.

But the account of our early life should be simple, detached from any motives of self-depreciation or self-assertion, and free from any desire to push any particular moral or psychological theory. We want to trace the dawn of ambition, the first glimmering in the child's mind that there is something that he can do better than his fellows and reminiscences of early likes and dislikes which, though apparently disconnected from maturer tendencies, may serve as indications of a deep-seated purpose in life. It may be difficult to resist the temptation of trying to justify one's reputation in the eyes of the world; but it is worth making the effort. The only example that I know of such an autobiographical sketch is that of Darwin, which is contained in his "Life and Letters," published by his son, Sir Francis Darwin.

The ambition of a child to be better, cleverer, or more beautiful than its fellows is in the main, I think, a wish to please and to be praised. As the child grows up, the ambition becomes more definite. It is not a sordid ambition for ultimate wealth or power, nor is it an altruistic ambition to do good for the sake of doing good. Occasionally it takes the form confessed to by Darwin, when he says: "As a child I was much given to inventing deliberate falsehoods, and this was always done for the sake of causing excitement." This desire to be conspicuous was, in Darwin's case, consistent with extreme modesty, amounting almost to a want of confidence in himself, as appears in this passage: "I remember one of my sporting friends, Turner, who saw me at work with my beetles, saying that I should some day be a Fellow of the Royal Society, and this notion seemed to me to be preposterous."

We next come to the stage where a child is attracted by one subject more than another, and, if his choice be free, will select it for his life's career. What guides him in this choice? If it be said that a boy gravitates towards that subject which he finds easiest, we are led to the further question why does he find it easiest? It is on this point that more information is required, but I am inclined to answer in accordance with Poincaré's views that it is because its particular beauty appeals most strongly to his emotional senses. In questions of this kind everyone must form his own conclusions according to his personal recollections, and these convince me that the emotional factor appears already at an early age. It is the strong attraction towards particular forms of reasoning, more perhaps even than the facility with which reasoning comes, that carries us over the initial difficulties and the drudgery that must accompany every serious study.

I have already alluded to the different tendencies of individuals either to prefer solitary reflection or to seek companionship. Almost in every profession we find men of both types. Darwin's autobiography furnishes a good example of the man who prefers to learn through quiet reading rather than through lectures, but to many men of science the spoken word is inspiring and contact with congenial minds almost a necessity.

From our present point of view the most interesting passages in Darwin's autobiography are those indicating the esthetic feeling which, like Poincaré, he connects with scientific research. Referring to his early studies we find this passage: "I was taught by a private tutor and I distinctly remember the intense satisfaction which the clear

geometrical proofs gave me. I remember with equal distinctness the delight which my uncle gave me by explaining the principle of the vernier of a barometer.'' To a man who apparently had no pronounced facility of mastering mathematical difficulties this feeling of satisfaction is especially remarkable. The combination of scientific ability with leanings either to music, or art, or poetry, is very common, and examples are to be found in almost every biography of men of science. It is difficult indeed to name an eminent scientific man who has not strong leanings towards some artistic recreation: we find the poetic vein in Maxwell and Sylvester, the musical talent in Helmholtz and Rayleigh, and the enthusiastic though amateurish pictorial efforts of less important men. That the similarities are to be found also in temperament may be noticed on reading Arnold Bennett's article on ''The Artist and the Public,''[9] where many passages will be seen to be applicable to students of science as well as to writers of fiction.

If we look for distinctions between different individuals, we may find one in their leanings either towards the larger aspects of a question or the microscopic study of detail. The power of focusing simultaneously the wider view and the minute observation is perhaps the most characteristic attribute of those who reach the highest eminence in any profession, but the great majority of men have a notable predilection for the one or other side. Though it is indispensable for a scientific man to study the details of the particular problem he is trying to solve, there are many who will lose interest in it as soon as they believe they can see a clear way through the difficulties without following up their solution to its utmost limits. To them detail, as such, has no interest, and they will open and shut a door a hundred times a day without being even tempted to inquire into the inner working of the lock and latch.

There is only one feature in the operation of the intelligence by means of which a sharp division may possibly be drawn between brain-workers showing special capabilities in different subjects. In some persons thought attaches itself mainly to language, in others to visualized images, and herein lies perhaps the distinction between the literary and scientific gift. Those who, owing to external circumstances, have resided in different countries are sometimes asked in what language they think. Speaking for myself, I have always been obliged to answer that, so far as I can tell, thought is not connected with any language at all. The planning of an experiment or even the critical examination of a theory is to me entirely a matter of mental imagery, and hence the experience, which I think many scientific men must have shared, that the conversion of thought into language, which is necessary when we wish to communicate its results to others, presents not only the ordinary difficulties of translation but reveals faults in the perfection or sequence of the images. Only when the logic of words finally coincides with the logic of images do we attain that feeling of confidence which makes us certain that our results are correct.

A more detailed examination of the instinctive predilections of a child would, I think, confirm Poincaré's conclusion that a decided preference for one subject is in the main due to an unconscious appeal to his emotions. It should be remembered, however, that the second step of Poincaré's philosophy is as important as the first. The mere emotional impulse would die out quickly, if it were not supplemented by the gratification experienced on discovering that the search for the beautiful leads us

[9] *English Review*, October, 1913.

to results which satisfy our intellect as well as our emotions. There may still be bifurcations in the second portion of the road. Some may rest content with achieving something that supplies the material needs of humanity, others may be inspired to search for the deeper meaning of our existence.

There remains therefore some justification for the question why we persist in studying science apart from the mere intellectual pleasure it gives us. It was once a popular fallacy to assume that the laws of nature constituted an explanation of the phenomena to which they applied, and people then attached importance to the belief that we could gauge the mind of the Creator by means of the laws which govern the material world, just as we might trace the purpose of a human legislator in an act of parliament. As this archaic interpretation was abandoned, philosophers went, in accordance with what politicians call the swing of the pendulum, to the other extreme. We can explain nothing, they said —in fact, we can know nothing—all we can do is to record facts. This modesty was impressive and it became popular. I know, at any rate, one scientific man who has acquired a great reputation for wisdom by repeating sufficiently often that he knows nothing, and, though his judgment may be true, this frame of mind is not inspiring. As a corrective to the older visionary claims, which centered round the meaning of the word "explain," the view that the first task of science is to record facts has no doubt had a good influence. Kirchhoff laid it down definitely that the object of science is to describe nature, but he did not thereby mean that it should be confined to recording detached observations: this would be the dullest and most unscientific procedure. Description, in the sense in which Kirchhoff uses it, consists in forming a comprehensive statement gathering together what, till then, was only a disconnected jumble of facts. Thus the apparently quite irregular motions of the planets, as observed from the earth, were first collected in tabular form. This was a necessary preliminary but was not in itself a scientific investigation. Next came Kepler, who by means of three laws summed up the facts in their main outlines, and the description then took a more refined form, substituting half a page of printing for volumes of observations. Finally, Newton succeeded in predicting the planetary movements on the assumption of a gravitational attraction between all elements of matter. According to Kirchhoff, the chief merit of this discovery would lie in its condensing Kepler's three laws into one hypothesis. This point of view is not necessarily opposed to that of Poincaré, because it is exactly the simplicity of Newton's explanation that appeals most strongly to our esthetic sense, but there is an important difference in the manner of expression. However beautiful an idea may be, it loses its effect by being placed before us in an unattractive form. This criticism also applies to Mach, according to whom the object of science is to economize thought, just as it is the object of a machine to economize effort. Logically, this definition is justified and it may be the best that can be given, if we prefer using a technical expression to confessing an emotional feeling. But why should we do so? Is it not better to recognize that human intelligence is affected by sentiment as much as by reasoning? It is a mistake for scientific men to dissociate themselves from the rest of humanity, by placing their motives on a different and, at the best, only superficially higher, level. When an adventurous spirit, for instance, desires to organize an expedition to unknown regions of the world, we try to induce our governments

to provide the necessary funds by persuading them, and incidentally ourselves, that we do so because important scientific results may be expected from the expedition. This may actually be the case, but we are mainly affected by the same motives as the rest of the community: if the truth be told, we are as curious as they to know what every corner of the earth looks like, and we join them in wishing to encourage an enterprise requiring perseverance and involving danger.

I fully realize that the wish to justify one's own work in the eyes of the world will always lead to fresh attempts to find a formula expressing the objects which we desire to attain. Enough, however, has been said to show that the definition must take account of sentiment, without insisting too much upon it. Nor can we hope, in view of the variety of intellectual and emotional pleasures which combine to create the charm of science, to include all points of view, but if I were forced to make a choice I should say that the object of science is to predict the future. The wish to know what lies before us is one of the oldest and most enduring desires of human nature; often, no doubt, it has degenerated and given rise to perverted and ignoble longings, but its accomplishment, when it can be achieved by legitimate inquiry, is a source of the purest and most satisfying enjoyment that science can give. We feel that enjoyment each time we repeat an old and perhaps hackneyed experiment. The result is known beforehand, but be it only that we expect the color of a chemical precipitate to be green or yellow, be it only that we expect a spot of light to move to the right or left, there is always a little tremor of excitement at the critical moment and a satisfying feeling of pleasure when our expectation has been realized. That pleasure is, I think, enhanced when the experiment is not of our own making but takes place uncontrolled by human power. In one of Heine's little verses he makes light of the tears of a young lady who is moved by the setting sun. "Be of good cheer," the poet consoles her, "this is only the ordinary succession of events: the sun sets in the evening and rises in the morning." If Heine had been a man of science, he would have known that the lady's tears found a higher justification in the thought of the immutable and inexorable regularity of the sun's rising and setting than in the fugitive color impression of his descent below the horizon, and that her emotions ought to be intensified rather than allayed by the thought of his resurrection in the morning—everybody's life contains a few unforgettable moments which at quite unexpected times, will vividly rise in his mind, and there are probably some in this hall who have experienced such moments at the beginning of a total eclipse of the sun. They have probably traveled far, and gone through months of preparation, for an event which only lasts a few minutes. The time of first contact is approaching, in a few seconds the moon is about to make its first incision in the solar disc, and now the observer's thoughts come crowding together. What if there were a mistake in our calculations? What if we had chosen a spot a few miles too far north or too far south? What if the laws of gravitation were ever so little at fault?—But now at the predicted time, at the calculated spot on the sun's edge, the dark moon becomes visible, and the feeling of relief experienced concentrates into one tense instant all the gratitude we owe those who have given precision to the predictions of celestial movements, leaving them expressible by a simple law which can be written down in two lines. It is this simplicity of the law of gravitation, and its accuracy which

some day may show limitations, but has hitherto withstood all tests, that gives to astronomy its preeminence over all sciences.

Indeed, if we classify the different sections into which science may be divided, I think it may be said that their aim, in so far as it is not purely utilitarian, is always either historic or prophetic; and to the mathematician, history is only prophecy pursued in the negative direction. It is no argument against my definition of the objects of science, that a large section of its sub-divisions has been, and to some extent still is mainly occupied with the discovery and classification of facts; because such classification can only be a first step, preparing the way for a correlation into which the element of time must enter, and which therefore ultimately must depend either on history or prophecy.

Latterly men of science, and in particular physicists, have given increased attention to the intrinsic meaning of the concepts by means of which we express the facts of nature. Everything—who can deny it?—is ultimately reduced to sense impressions, and it has therefore been asserted that science is the study of the mind rather than of the outside world, the very existence of which may be denied. The physicist has thus invaded the realm of philosophy and metaphysics, and even claims that kingdom as his own. Two effects of these efforts, a paralyzing pessimism and an obscure vagueness of expression, if not of thought, seriously threatened a few years ago to retard the healthy progress of the study of nature. If the outside world were only a dream, if we never could know what really lies behind it, the incentive which has moved those whose names stand out as landmarks in science is destroyed, and it is replaced by what? By a formula which only appeals to a few spirits entirely detached from the world in which they live. Metaphysicians and physicists will continue to look upon science from different points of view, and need not resent mutual criticisms of each other's methods or conclusions. For we must remember that most of the good that is done in this world is done by meddling with other people's affairs, and though the interference is always irritating and frequently futile, it proves after all that our interests converge towards a common center.

According to Poincaré, the pleasure which the study of science confers consists in its power of uniting the beautiful with the useful; but it would be wrong to adopt this formula as a definition of the object of science, because it applies with equal force to all human studies. I go further, and say that the combination of the search for the beautiful with the achievement of the useful is the common interest of science and humanity. Some of us may tend more in one direction, some in another, but there must always remain a feeling of imperfection and only partial satisfaction unless we can unite the two fundamental desires of human nature.

I have warned you at the beginning of this discourse not to beat the utilitarian drum too loudly, and I have laid stress throughout on the idealistic side, though the most compelling events of the moment seem to drive us in the other direction, and the near future will press the needs of material prosperity strongly upon us. I must guard myself, therefore, against one criticism which the trend of my remarks may invite. At times, when the struggle for existence keeps masses in permanent bondage, in a society in which a multitude of men and women have to face starvation, and when unfortunate, though purely accidental, surroundings in childhood drive the weak into misery, is it not futile to speak of esthetic motives? Am I not,

while endeavoring to find a common bond between all sections of the community, in reality drawing a ring round a small and privileged leisured class, telling them these enjoyments are for you and for you alone? Should I not have found a surer ground for the claims of science in its daily increasing necessity for the success of our manufactures and commerce?

I have said nothing to indicate that I do not put the highest value on this important function of science, which finds its noblest task in surrendering the richness of its achievements to the use of humanity. But I must ask you to reflect whether the achievement of wealth and power, to the exclusion of higher aims, can lead to more than a superficial prosperity which passes away, because it carries the virus of its own doom within it. Do we not find in the worship of material success the seed of the pernicious ambition which has maddened a nation, and plunged Europe into war? Is this contempt for all idealistic purposes not responsible for the mischievous doctrine that the power to possess confers the right to possess, and that possession is desirable in itself without regard to the use which is made of it? I must therefore insist that if we delight in enlisting the wealth accumulated in the earth, and all the power stored in the orbs of heaven, or in the orbits of atomic structure, it should not be because we place material wealth above intellectual enjoyment, but rather because we experience a double pleasure if the efforts of the mind contribute to the welfare of the nation. When Joule taught us to utilize the powers at our disposal to the best advantage he did it not—and his whole life is a proof of it—to increase either his own wealth or that of the nation, but because, brought up in commercial life and deeply imbued with the deep insight and genius of science, he found his greatest delight in that very combination of esthetic satisfaction and useful achievement which Poincaré has so well described. And again, when another of our fellow-citizens, Henry Wilde, showed how electrical power can be accumulated until it became an efficient instrument for the economic transmission of work, he found his inspiration in the intellectual gratification it gave him, rather than in the expectation of material gain. I am drawing no ring round a privileged class, but urge that the hunger for intellectual enjoyment is universal and everybody should be given the opportunity and leisure of appeasing it. The duty to work, the right to live, and the leisure to think are the three prime necessities of our existence, and when one of them fails we only live an incomplete life.

I should have no difficulty in illustrating by examples, drawn from personal experience, the power which the revelations of science can exert over a community steeped in the petty conflicts of ordinary life; but I must bring these remarks to a conclusion, and content myself with the account of one incident.

An American friend, who possessed a powerful telescope, one night received the visit of an ardent politician. It was the time of a presidential election, Bryan and Taft being the opposing candidates, and feeling ran high. After looking at clusters of stars and other celestial objects, and having received answers to his various questions the visitor turned to my friend:

> And all these stars I see, he asked, what space in the heaven do they occupy?
>
> About the area of the moon.
>
> And you tell me that every one of them is a sun like our own?
>
> Yes.
>
> And that each of them may have a number of planets circulating round them like our sun?
>
> Yes.
>
> And that there may be life on each of these planets?

We can not tell that, but it is quite possible that there may be life on many of them.

And after pondering for some time, the politician rose and said: It does not matter after all whether Taft or Bryan gets in.

Happy were the times, when it could be said with truth that the strife of politics counted as nothing before the silent display of the heavens. Mightier issues are at stake to-day: in the struggle which convulses the world, all intellectual pursuits are vitally affected, and science gladly gives all the power she wields to the service of the state. Sorrowfully she covers her face because that power, accumulated through the peaceful efforts of the sons of all nations, was never meant for death and destruction; gladly she helps, because a war wantonly provoked threatens civilization, and only through victory shall we achieve a peace in which once more science can hold up her head, proud of her strength to preserve the intellectual freedom which is worth more than material prosperity, to defeat the spirit of evil that destroyed the sense of brotherhood among nations, and to spread the love of truth.

ARTHUR SCHUSTER

THE MIGRATIONS OF DISTINGUISHED AMERICANS

WHERE do great men go? Do they go anywhere? Are the recognized leaders of activity and thought in the class of "rank outsiders" or have they been born and brought up in the same spot which now marks the field of their labors?

These questions can not be answered finally for two reasons. In the first place, because there is no perfectly authentic record from which the names of all leaders may be gleaned, and second, because the available records are in many cases faulty. Nevertheless, the eighteen thousand names listed by "Who's Who in America" contains a large proportion of the leading men of the country, and even though the list does contain the names of many who are not recognized leaders, it is, on the whole, an excellent weathervane for America's great and near-great in the mass.

Among other suggestive facts, "Who's Who"[1] tells for each person whose biography appears, the place of birth and the present address. By comparing the two, for a large number of cases, the facts regarding the movements of great men may be ascertained.

A study of "Who's Who" shows two distinct movements, one from the east and south to the north and west; the other from the country district and the small town to the great city. The great men born in the east and south have gone west in large numbers. At the same time, many of the leaders in city life came from outside the city.

The movement of great men from the east to the west is strikingly apparent. Among 16,449 distinguished persons whose names appear in "Who's Who," over nine-tenths (91.6 per cent.) were born in the New England, Middle Atlantic states, the East North Central, South Atlantic and East South Central states. This division includes roughly the territory east of the Mississippi River. Although only one twelfth of the distinguished persons were born west of this division line, at the present time, one sixth (16.8 per cent.) resides there. The migrations from the Eastern states have been felt most heavily in New England and in the East North Central states. Among the persons listed in "Who's Who," 3,764 (22.9 per cent.) were born in New England—2,921 (16.2 per cent.) now live there; 3,609 (22.0 per cent.) were born in the East North Central states—2,919 (16.2 per cent.)

[1] "Who's Who" is published in Chicago. The editor, Albert Nelson Marquis, was born in Ohio. "The standards of admission to 'Who's Who in America' divide the eligibles into two classes: (1) Those who are selected on account of special prominence in creditable lines of effort, making them the subjects of extensive interest, inquiry or discussion in this country; and (2) those who are arbitrarily included on account of official position—civil, military, naval, religious or educational—or their connection with the most exclusive learned or other societies." From a statement following the preface, 1912–13 edition.

now reside there. The gains have been most notable in the Mountain and Pacific states. Among the persons listed in "Who's Who," 48 (.3 per cent.) were born in the Mountain states—466 (2.5 per cent.) now reside there; 207 (1.2 per cent.) were born in the Pacific states—865 (4.8 per cent.) now reside there. Apparently the northeastern section of the United States has lost heavily in favor of the extreme western portion of the country. Although producing a negligible portion of the total distinguished persons, the western states are gaining considerably through the migration of distinguished persons from their birthplace.

An excellent corroboration of this appears from a study of specific states. Among the Eastern states, Massachusetts, New York, New Jersey and Illinois alone have more distinguished persons now resident than were born in them. At the same time, Minnesota and Florida have a resident population of distinguished persons larger than the number born there. With the exception of Florida and the District of Columbia, these states are western and southwestern states. The opposite condition appears if a list is made of those states in which fewer distinguished persons are resident than the number born. In this list appear Maine, New Hampshire, Rhode Island, Connecticut, Vermont, Pennsylvania, Ohio, Indiana, Michigan, Wisconsin and Iowa together with eleven of the southern and east south central states.

The total number of persons native born in the states having more distinguished persons now resident than were born in them was 7,302; the total number now resident in these same states is 12,058. The total number of persons born in the other group of states was 9,119; and the total number now resident is 6,042.

A similar result may be arrived at by making a table showing the number of states in which the resident distinguished persons are larger or smaller than the number native born distinguished persons.

If the statistics are carried out in the form of ratios, it appears that there were 12 states in which the ratio of distinguished now resident to distinguished born persons was less than 74 per hundred. All of the states with the exception of Wisconsin were in the eastern and northeastern parts of the United States. At the same time, there were 19 states in which the ratio of distinguished persons now resident to distinguished persons native born was over 175 per hundred. Every one of these states, except Florida, was west of the Mississippi.

A CLASSIFICATION SHOWING THE NUMBERS OF STATES IN WHICH THE NUMBER OF RESIDENT DISTINGUISHED PERSONS WAS LARGER AND IN WHICH THE NUMBER WAS SMALLER THAN THE NUMBER BORN IN THOSE STATES, CLASSIFIED BY GEOGRAPHICAL DIVISIONS

Division	Number of States in Which Number of Resident Distinguished Persons is Larger	Smaller
United States		
New England	1	5
Middle Atlantic	2	1
East North Central	1	4
West North Central	6	1
South Atlantic	2	7
East South Central	0	4
West South Central	4	0
Mountain	8	0
Pacific	3	0

There seems to be no question but that the great men of the present generation have been moving steadily westward. The older parts of the country produced them, but they have persistently found their way into the newer parts. Some critics will contend that this is merely another way of saying that the opportunities of the new territory brought out the latent abilities of those who went there. While such a view may have some justification, the fact can not be lost sight of that while the west was gaining so persistently, the east was as steadily losing.

The facts regarding the movement into the cities are less conclusive, but none the less significant.

Of the four northeastern states showing a larger number of distinguished persons now resident than the number native born were

Massachusetts, New York and Illinois. In each of these states is at least one great city center of commerce and industry. Had this fact any influence upon the position of these three states? In order to answer this question, the consecutive names of 2,000 native-born persons were taken at random.[2] Among this 2,000, 549 were born in cities of more than 100,000 population, and 1,365 are now resident in these cities. The figures for New York, Chicago, Philadelphia, Boston and Washington show 317 born in these cities, and 791 now resident. The figures for New York, Philadelphia, St. Louis, San Francisco, Washington, Baltimore and Chicago show 355 born and 851 now resident. The proportion absorbed by the larger cities is not, on the whole, greater than the proportion absorbed by urban as opposed to rural life.

One thing the figures show conclusively, that there has been a marked movement of distinguished persons from the northeastern section of the United States to that section west of the Mississippi and particularly that section included in the Pacific and Mountain states. City life is in no large sense responsible for this movement. It is evidently a logical reaction to the wide range of opportunity which the west affords.

SCOTT NEARING

SCIENTIFIC NOTES AND NEWS

DR. MAX PLANCK, professor of physics at Berlin, and Professor Hugo von Seeliger, director of the Munich Observatory, have been made knights of the Prussian order pour le mérite. Dr. Ramón y Cajal, professor of histology at Madrid, and Dr. C. J. Kapteyn, professor of astronomy at Gröningen, have been appointed foreign knights of this order.

M. GEORGES VAN BIESBROECK, Dr. Ing., adjunct astronomer at the Royal Observatory of Belgium, situated at Uccle, has joined the staff of the Yerkes Observatory, University of Chicago, for the academic year 1915–16, with the title of visiting professor of practical astronomy. His work will be chiefly devoted to double stars and to the regular program of determining stellar parallaxes from photographs made with the 40-inch refractor.

THE second Pan-American Scientific Congress, which will meet in Washington, December 27, 1915, and adjourn January 8, 1916, will be divided into nine sections, which, with their chairmen, are as follows: Anthropology, William H. Holmes; Astronomy, Meteorology and Seismology, Robert S. Woodward; Conservation of Natural Resources, George M. Rommel; Education, P. P. Claxton; Engineering, W. H. Bixby; International Law, Public Law and Jurisprudence, James Brown Scott; Mining and Metallurgy, Economic Geology and Applied Chemistry, Hennen Jennings; Public Health and Medical Sciences, William C. Gorgas; Transportation, Commerce, Finance and Taxation, L. S. Rowe.

DR. THEOBALD SMITH, head of the division of comparative pathology of the Rockefeller Institute for Medical Research, should be addressed at Princeton, N. J., after October 1.

DR. RICHARD PEARSON STRONG is returning to this country from Servia to resume his position as professor of tropical medicine in Harvard Medical School.

DR. SEISHU KENOSHITA, professor of gynecology and obstetrics in the Imperial University, Tokyo, Japan, has been designated by the government to make an extensive tour and study of American hospitals.

NEWS has been received of the safe return of Vilhjalmar Steffanson, who has been conducting a Canadian expedition to the far north. He expects to spend two more years in exploration.

DR. STOCK, professor of chemistry at Munich, has been appointed a member of the Kaiser Wilhelm Institute for Chemistry at Dahlem.

DR. ELISHA H. COHOON has been appointed administrative head of the psychopathic department of the Massachusetts State Hospital, at Boston. Dr. E. E. Southard, who has been director of the institution for a number of years, will be relieved of his administrative duties, but will retain the title of director and

[2] They started with I. F. Merrifield, and ended with H. W. Ranger.

will have charge of the scientific research laboratories of the hospital.

Dr. Thomas B. Shea, Boston, has been appointed chief of the medical division of the department of health. Dr. H. Mulloney, formerly a member of the Boston Board of Health, has been appointed a deputy health commissioner. Dr. Francis H. Slack, formerly secretary of the board of health, has been made deputy in the bacteriologic department.

F. L. Drayton has been appointed assistant botanist at the Canadian Experimental Farms, and George W. Muir, assistant animal husbandman at the Nova Scotia Agricultural College. J. A. Sinclair has succeeded J. Standish in the veterinary department, and C. A. Good has been appointed assistant entomologist.

Dr. Friedrich Hildebrandt, formerly professor of botany at Freiburg, has celebrated his eightieth birthday.

The Weber-Parkes prize of the Royal College of Physicians for 1915 has been awarded to Dr. Noel Dean Bardswell.

A. Müller, of Berlin, who has perfected the accumulator used in submarine boats, has been made doctor of engineering by the Technical School of Hanover.

A bronze bust of the late Dr. S. Weir Mitchell has been presented by Mr. and Mrs. Walter D. Ladd to the Jesup Memorial Library in Bar Harbor.

Dr. Edward Nelson Tobey, of St. Louis, was a passenger on the fruit steamer *Marowijne*, which has not been heard from since August 13, and is believed to have been wrecked by a hurricane in the Gulf of Mexico or the Caribbean Sea on that date. Dr. Tobey was one of the medical party sent by the St. Louis University to British Honduras at the beginning of the summer. He was a lecturer in the medical department of the university and an assistant city bacteriologist.

Charles Hallet Wing died on September 13 in his eightieth year. He was born in Boston and was graduated from Harvard College. In 1870 he became professor of chemistry at Cornell University, from which place he went in 1874 to Boston to accept a like position at the Massachusetts Institute of Technology, where he remained for ten years.

John E. Sinclair, professor emeritus of higher mathematics at the Worcester Polytechnic Institute, died on September 12. He was born in 1838 and attended the Exeter Latin School and later the Chandler School at Dartmouth College. After he was graduated he went to Adrian, Mich., to teach, and later to St. Louis, Mo. In 1863 he returned to Dartmouth as professor of mathematics and was awarded the degree of Ph.D. there. In 1869 he went to Worcester Polytechnic Institute as professor of higher mathematics, from which position he retired six years ago as professor emeritus.

Professor B. Fischer, director of the hygienic laboratory of the University of Kiel, has died in one of the military hospitals at the age of sixty-three years.

Professor M. Rothmann, of Berlin, died on August 12, aged forty-seven years. He is known for his work on the localization of brain functions and was responsible for the establishment of the anthropoid station in Teneriffe.

G. Cattaneo, for half a century professor of surgery at the University of Pavia, has died at the age of eighty-three years. He bequeathed most of his property to found an institution there for treatment of the maimed and crippled.

As a piece of constructive work in conservation, the New York State College of Forestry, at Syracuse, has begun this summer an ecological survey of Oneida Lake. Special attention will be given to the fishes. Oneida Lake has an area of 81 square miles, a maximum depth of 55 feet, a length of 21 miles and an average width of about 6 miles. It has a large area of shallow water, is bordered by extensive swamps, abounds in fish, and a state fish hatchery is located on it at Constantia. Mr. Frank C. Baker, recently acting director of the Chicago Academy of Science, a well-known specialist on molluscs, will study the relation of molluscs to the feeding and breed-

ing grounds of fish, and Professor T. L. Hankinson, of the Eastern Illinois Normal School, Charleston, Ill., will with Dr. Charles C. Adams, of the College of Forestry, investigate the ecology of the fish.

A COOPERATIVE plan for the study of the underground waters in the southeastern corner of Montana under an area of about ten thousand square miles has been arranged by O. E. Meizner representing the U. S. Geological Survey, with the chemical department of the Montana State College and the chemical laboratory at the college which does the work for the Montana board of health. Under the arrangement the field work will be done by the geological survey and the analyses amounting to about two hundred will be done by the State College and the board of health under the direction of Professor W. M. Cobleigh. The work is to be completed by July 1, 1916. The study deals with the mineral content of the waters only and is of importance both to the agricultural interests of the state and to the public health as affecting the matter of domestic water supply.

DR. LUCY L. W. WILSON, head of the department of nature study and geography of the Philadelphia Normal School, excavated this summer at the prehistoric site called Otowi, New Mexico, for the Philadelphia Commercial Museums, of which her husband, Dr. W. P. Wilson, is the director. She has returned with a fine collection of prehistoric pottery including a dozen unbroken bowls, about thirty bowls of which all of the pieces have been secured, and forty pieces of pottery of which at least half is intact. Every type of pottery is represented, including even a small piece of very ancient basket ware, a whole bowl of incised ware, some coiled ware, plenty of the biscuit, the hard "black and white," and the glazed patterns. Many clay food bowls, ollas, tinajes, ceremonial bowls and ceremonial pipes were found. A potter's outfit was dug out, consisting of balls of red and white clay, mica clay (for cooking pots), smoothing stones, shaping stones and paint pots. A great quantity of stone ware was excavated, much of which has been left *in situ*, although a good collection of domestic and hunting utensils and implements has been shipped to the museum. Over fifty skeletons were disinterred, but all except fifteen were reburied, chiefly because they were not in good condition. The most important find was a "basket-burial" in a room underneath the floor. On the body were many ceremonial objects—two rain sticks and about a dozen prayer sticks. The feet were in a glazed bowl. The mouth was full of corn and cobs of corn were on the face, the neck, the chest. A dozen ceremonial pipes and a small copper pendant were found in the same room. Another unusual burial was that of a child in a bowl with a couple of clay playthings near by. Most of the adults were buried in the usual reflexed position with the face toward the west. Two skeletons, however, were found face down. One of these had a long ceremonial pipe of serpentine in his mouth.

WE learn from *Nature* that the Royal Society is compiling a register of scientific and technical men in Great Britain and Ireland, who are willing to give their services in connection with the war. The register will be classified into subjects, and will ultimately constitute a large panel of men of standing, whose services will be available whenever any government department or similar authority requires specialist assistance. The register is being coordinated with those independently compiled by other societies and institutions, but the Royal Society would be glad to have applications for forms from such members of the staffs of colleges and technical institutions as have not yet been registered by any society. The Royal Society is also drawing up, with the cooperation of the principal societies and institutions, a list of scientific and technical men actually on active service in the army and navy.

THE medical secretary of the British Medical Association has made a report on the medical war register and the work hitherto done by the committee, according to which the physicians in England, Wales and Ireland are distributed as follows:

1. The number of men already on whole-time war service (total, 5,265).

2. The number of men of 50 years of age and over offering whole-time war service (total, 447).

3. The number of men from 40 to 49 offering whole-time war service (total, 436).

4. The number of men of 40 and under offering whole-time war service (total, 633).

5. The number of men of 40 and under not on whole-time war service, nor offering to undertake it (total, 6,555 up to date).

From these figures it will be seen that there are approximately 6,555 men of military age not at present engaged in war service; of these the services of about one third are said to be needed.

The Berlin correspondent of the *Journal* of the American Medical Association reports that the Kaiser Wilhelm Institute for the Study of the Physiology and Pathology of the Workingman has now begun its work. Researches will be made in the physiology, pathology and hygiene of labor (work), the mental and physical welfare of the workingman. The relationship of labor to the age of the workingman, the sex, the race, nourishment, environment, clothing, etc., will be investigated. The physiologic chemistry department will investigate particularly the physiology of nutrition in order to determine the influence of food on the working capacity of the workingman and the influence of alcohol on muscle energy. The statistical division will approach the question from another point of view including a study of food and food elements, animal as well as vegetable, the size of a family as bearing on the nutrition, the difference in eating in the city and in the country among the poor and among the rich. The psychologic division will investigate the influence of labor in its relationship to psychathenia, etc. The work done by others in similar fields will place these studies on a definite basis. The well-known Taylor system has done much to further these studies; for instance, it is known that severe physical labor causes the blood to leave the viscera and appear in increased quantity in the extremities. Physical tire, on the other hand, produces the opposite. Therefore deleterious effects may be prevented by regulating the work either by frequent periods of rest or by changing the kind of work so that other muscle groups may be brought into play. It is the aim of the institute to investigate all the phases of this question thoroughly so that the results may prove beneficial to the workingman as well as to his employer. Tuberculosis will come in for a large share of study, especially with regard to the etiologic relationship of poor housing conditions in the cause and spread of tuberculosis. The alcohol question, female and child labor, etc., will be investigated.

The finest and most accurate maps of the United States are those made by the United States Geological Survey. This branch of the government service prints more than 3,000 maps a day, or about a million a year, most of which are sold to the public directly from Washington. Book and stationery concerns in the larger cities of course handle these maps, but heretofore there has been no way in which the inhabitants of the small towns throughout the country could get them except by sending to Washington. Now, however, postmasters in towns and villages have the permission of the Post Office Department to handle these maps. When the Geological Survey prints a new map it sends a sample copy to the postmasters in the area covered, with the suggestion that they tack it up in a conspicuous place, where everyone calling for mail can see it, and order a small stock for sale to those who wish to buy the map. This saves the purchaser the annoyance of sending to the Geological Survey and waiting until the map is received from Washington and also saves the expense of postage. The postmaster himself receives a small commission on each map sold. Many active postmasters are handling the maps, and that their fellow-citizens appreciate the accommodation of being able to buy government maps at the post office is shown by the number sold in this way. The record of maps so sold shows that a postmaster in Minnesota heads the list so far, having sold 125 maps the first month he handled them. Only postmasters in regions that have been recently mapped have been asked to handle the maps,

but the Geological Survey willingly answers inquiries made by other postmasters, sending them a sample copy of the map that covers their district, if it has been mapped. It is believed that this new plan of distributing the government maps will benefit all concerned; it will be a convenience to the purchasers, it will bring the postmasters a small commission, and it will increase the sale of the maps.

THE registrar-general for England and Wales has issued his return relating to the births and deaths in the second quarter of the year, and to the marriages in the three months ending March last. From a report in the *British Medical Journal* we learn that the marriage-rate during that period was equal to 12.0 per 1,000, which was 0.8 per 1,000 more than the mean rate in the corresponding periods of the ten preceding years. The 213,094 births registered in England and Wales last quarter were equal to an annual rate of 22.9 per 1,000 of the population, estimated at 37,302,983 persons. This rate is 3.3 per 1,000 below the mean rate in the ten preceding second quarters, and is the lowest rate recorded in the second quarter of any year since civil registration was established. The birth-rates in the several counties last quarter ranged from 16.0 in Sussex, 17.0 in Somerset, 17.1 in Westmorland and 17.3 in Cardigan, to 27.2 in Stafford, 27.3 in Carmarthen, 27.5 in Northumberland, 28.3 in Glamorgan, 28.5 in Monmouth and 30.8 in Durham. The excess of births over deaths last quarter was only 74,515, against 102,293, 105,727 and 101,933 in the second quarters of the three preceding years. From a return issued by the board of trade it appears that between the United Kingdom and places out of Europe the arrivals of persons stated to be of British nationality exceeded the departure by 8,583 persons, while the numbers of aliens leaving exceeded those arriving by 431. The balance of the aggregate passenger movement in the quarter to and from all countries was 6,580 inward. The 138,579 deaths registered in England and Wales during the quarter under notice were equal to an annual rate of 14.9 per 1,000, against an average rate of 13.7 per 1,000 in the corresponding quarter of the ten preceding years. The death-rates in the several counties last quarter ranged from 11.2 in Middlesex, 12.0 in Essex and in Rutland, 12.4 in Berkshire, and 12.5 in Buckinghamshire and in Dorset, to 17.2 in Cumberland, 17.3 in Montgomery, 17.7 in Durham, 17.8 in Denbigh, 18.3 in the North Riding of Yorkshire and 18.4 in Cardigan. The 138,579 deaths from all causes last quarter included 311 which were attributed to enteric fever, 6 to smallpox, 6,724 to measles, 590 to scarlet fever, 2,589 to whooping-cough, 1,176 to diphtheria and 1,496 to diarrhea and enteritis among children under 2 years of age. The mortality from measles was nearly double the average, and that from diphtheria was slightly above the average; from scarlet fever and whooping-cough the mortality was slightly below the average, and that from enteric was 40 per cent. below. The rate of infant mortality, measured by the proportion of deaths among children under 1 year of age to registered births, was equal to 97 per 1,000, which was 2 per 1,000 above the mean rate in the ten preceding second quarters.

STATISTICS compiled under the supervision of J. D. Northrop, of the United States Geological Survey, show that the quantity of natural gas commercially utilized in the United States in 1914 exceeded that so utilized in any previous year in the history of the natural gas industry. The quantity produced, which amounted to approximately 591,866,733,000 cubic feet, valued at $94,115,524, constitutes a new record of production exceeding by nearly 10 billion cubic feet, or almost 2 per cent., the former record, established in 1913. Increases in output in 1914 over 1913 were credited to New York, Ohio, Oklahoma, Texas, Louisiana-Alabama, Iowa and California, the state last named alone recording a gain of nearly 7 billion cubic feet. Other gas-producing states recorded declines in output the greatest of which, that of Pennsylvania, amounting to slightly more than 10 billion cubic feet. The increases in gas production may be attributed to various causes—in New York to the in-

creased drilling activity stimulated by the advancing petroleum market in 1913 and the early part of 1914; in Ohio to local extensions of the productive fields of the gas belt in the central part of the state and to the development of an important gas pool in the vicinity of Cleveland, Cuyahoga County; in Oklahoma to the development of gas reserves in the Cushing field, Creek County, and the Healdton field, Carter County, as well as to a decided expansion of the local casinghead gasoline industry; in Texas to a greater utilization of the gas supplies available in the Petrolia and Mexia fields; in Louisiana to the greater development of the gas reserves in Caddo and De Soto parishes, and in California to increased demands for domestic consumption in Los Angeles and adjacent towns in the southern part of the state as well as for industrial consumption in the casinghead gasoline industry. Of the record-breaking production of natural gas credited to 1914 it is estimated that the total of 203,104,358,000 cubic feet, about 34 per cent., was supplied to domestic consumers at an average price of 28.04 cents a thousand cubic feet and that 388,762,375,000 cubic feet, the remaining 66 per cent., was supplied to industrial consumers at an average price of 9.56 cents a thousand cubic feet. During the last four years the ratio of domestic to industrial consumption has varied but slightly. Formerly, however, a relatively greater proportion of the annual yield was supplied to industrial consumers.

The Alaskan Engineering Commission, which is to build the government railroad from Seward on the Pacific 471 miles to Fairbanks in the interior, has received a permit from the Forest Service to cut 85 million feet of timber in the Chugach National Forest for use in constructing the new line. The permit was issued by the district forester at Portland, Oregon, who has direct supervision of the Alaskan forests, and is in conformity with the Act of March 4, last, which authorized the Secretary of Agriculture to permit the Alaskan Engineering Commission and the Navy Department to take from the national forests free of charge earth, stone and timber for use in government works. The timber will be cut in designated areas along the right-of-way of the proposed railroad, which runs through the Chugach National Forest for several miles. Experiments and tests of Alaskan spruce and hemlock are being made at the Forest Service Laboratory at Seattle, Washington, and so far have substantiated the opinion of foresters that Alaskan timber is sufficiently strong for practically all structural purposes. While these tests are going on Forest Service employees in Alaska are marking the timber to be cut along the proposed railroad, the cutting to be done so that only mature trees are taken, the young trees being left uninjured and the condition of the forest improved. This cut of 85 million feet will be the largest amount of timber ever felled on the Alaskan forests in one operation, and at the average rate per thousand board feet obtained for timber sold from the Chugach forest during the fiscal year 1914, it is worth approximately $145,000 on the stump. It will be nearly twice as much as the total quantity of national forest timber now cut and used annually for local purposes throughout Alaska, but only a little more than one tenth of the estimated annual growth of the Alaskan forests. The two national forests of Alaska contain about 78 billion feet of merchantable timber and it is estimated by the Forest Service that more than 800 million feet could be cut every year forever without lessening the forests' productivity.

The output of bituminous coal in the United States for the first six months of 1915 is estimated by C. E. Lesher, of the United States Geological Survey, to be between 180,000,000 and 190,000,000 short tons, the rate of production having been from 85 to 90 per cent. of the average for the previous year. Thus the bituminous coal production during this six-months' period has been considerably less than for the corresponding period in 1914, and is little, if any, greater than the output during the last half of that year. The rate of production this year decreased after January,

reached low ebb in March and April, and is now on the increase. The states west of Mississippi River, which in 1914 produced less than 13 per cent. of the total, do not appear to have suffered from this decrease as much as the eastern states—reports from certain districts in the west showing an increase over 1914. This is attributed to the increase in metal mining and smelting, and to greater railroad activity. In the east the loss of bunker trade on the Atlantic seaboard and the slowness of the Lake season have been only partly offset by the increasing coal exports. The recent activity in the iron business has been slow to affect the coal trade, although coke has gained considerably during the last two months and for the rest of 1915 the increased output should continue. The anthracite producers have fared better than the soft coal operators, since it is estimated that the output of anthracite has fallen off only from 3 to 5 per cent. below the average for 1914.

THE portion of the National Forest receipts for the fiscal year 1915 to go to the benefit of the various states in which the forests lie, according to the computation of the forest service just approved by the secretary of the treasury, amounts all told to more than $850,000. The gross receipts for the year ending June 30 were $2,481,469.35, of which under the law 25 per cent. is paid over to the states for county school and road purposes and an additional 10 per cent. is made available for expenditure by the secretary of agriculture in building road and trails for the benefit of local communities. Montana gets the largest share, having contributed the largest amount of receipts for the sale of timber, grazing and other uses of the forests, or more than $318,000. Of this amount, Montana is to receive $79,589.78 for county school and road purposes, while the forest service will expend $31,835.91 for improvements of special benefit to local communities and not included in the regular administrative and protective improvements. Idaho comes second with a 25 per cent. allowance of $75,651.15 and a 10 per cent. fund of $30,260.46. California is third, receiving a 25 per cent. allowance of $67,611.87 and a 10 per cent. fund of $27,044.74. The total amount to be expended under this system of sharing the forest receipts with the states to make up for the loss of local taxes due to public ownership of the land is about $16,000 greater than for the previous fiscal year, as the receipts for the fiscal year 1915 exceeded those of the previous fiscal year by about $44,000. The provision of law under which a portion of the receipts is turned over to the states dates from 1906, and the total payments reach, with this year's allotment, nearly $4,500,000. The ten per cent. provision for government-built public roads has been in force only since 1912, and has now made available for this purpose an aggregate of $926,000.

UNIVERSITY AND EDUCATIONAL NEWS

THE Southern Methodist University, Dallas, Texas, begins its initial session September 22. This is a coeducational institution under the auspices of the Methodist Episcopal Church South. The assets of the university in grounds, buildings and endowment amount to about one million and seven hundred thousand dollars. This university is to become the head of the southern Methodist colleges west of the Mississippi River. An active campaign is now being waged for an additional million dollars. The following appointments have been made on the scientific staff: Robert S. Hyer, A.M., LL.D., professor of physics; Frederick M. Duncan, Ph.D., professor of biology; John Henry Reedy, Ph.D. (Yale), professor of chemistry; Ellis W. Shuler, Ph.D. (Harvard), associate professor of geology.

PLANS have been approved by the board of regents of the University of Nebraska for a new hospital in connection with the College of Medicine at Omaha. The building is to be five stories in height and will have six wards of sixteen beds each, three receiving rooms. six groups of isolation rooms of three beds each, and the necessary operating rooms, operating amphitheater, and rooms for administration and service.

At the sixty-third annual meeting of the American Pharmaceutical Association, which was held in San Francisco during the week of June 9, the president of the association, Mr. Caswell A. Mayo, of New York, announced that Mr. Samuel W. Fairchild had agreed to provide funds for a scholarship in pharmacy paying $300 annually, to be awarded to an undergraduate student by a commission composed of the presidents of the American Pharmaceutical Association, the American Conference of Pharmaceutical Faculties, the National Association of Boards of Pharmacy, and the editor of the *Journal of the American Pharmaceutical Association.*

Two new foundations are announced at Leeds University—the William Walker scholarship, of the annual value of £90, for the scientific study of leather with a view to its subsequent application to industrial development, and the William Walker Exhibition, for instruction in the technology of coal and its by-products. The new endowments are founded in memory of the late Mr. William Walker, of Whitehaven, by his widow and his sons, Mr. Herbert W. Walker and Mr. Arthur Walker. Both are primarily tenable at Leeds by inhabitants of the Whitehaven and Bootle districts, and the donors have placed £4,500 in trust for the purpose.

Professor Ivey F. Lewis, of the University of Missouri, has become Miller professor of biology and head of the school of biology at the University of Virginia.

At the Montana State College, R. H. Bogue, formerly at the Massachusetts Agricultural College, has been appointed assistant professor of chemistry and geology; Henry M. Shea, formerly of the South Dakota State College, analyst of the food and drug laboratory, and H. B. Foote, formerly of Oklahoma, instructor in botany.

Dr. Paul H. Dike has been appointed professor of physics in Robert College, Constantinople, to succeed Professor Manning, who died last year. He sailed on the Greek line to Piraeus on September 15 with his family, together with a number of the members of the faculty of Robert College. The college is to open in spite of the war, and it is hoped that the party will be able to get through without much delay. The women and children will await developments in Athens.

DISCUSSION AND CORRESPONDENCE

THE LAWS OF MOTION

How well some of us remember and how much some of us have heard of the days of Thomson and Tait, and how satisfied we were and are with what Thomson and Tait had to say on this subject! In those days scarcely any one understood the laws of motion, but nowadays, thanks largely to the influence of Thomson and Tait, the chief confusion is that which rises from slightly different points of view, mostly correct; and the laws of motion now constitute the topic in the discussion of which one pays the least attention to what others say, and quite properly so.

We do, however, believe that it is misleading to speak of *the* fundamental equation of dynamics. Given three bodies A, B and C, and three identifiable forces a, b and c. Let the acceleration of each body due to each force be observed, and let the results be as shown in the accompanying table.

TABLE OF OBSERVED ACCELERATIONS

		Bodies		
		A	B	C
Forces	a	25	30	35
	b	50	60	70
	c	75	90	105

The acceleration varies from body to body for a given force, and from force to force for a given body. These are two equally fundamental modes of variation, and corresponding to them we have two equally fundamental laws of variation; and these laws of variation are entirely independent of the measurement of force and mass. Let us suppose that the above table has been extended so as to include a great many different forces and a great many different bodies, then a careful inspection of

the table would lead to the following generalizations.

(*a*) If one force produces twice as much acceleration as another force when acting on a given body, then the one force produces twice as much acceleration as the other force when acting on any body whatever.

(*b*) If one body is accelerated twice as much as another body under the action of a given force, then the one body is accelerated twice as much as the other body under the action of any force whatever.

The experimental fact (*a*) makes it convenient to define the ratio of two forces as the ratio of the accelerations they produce when acting on a given body, because this ratio is the same for all bodies.

The experimental fact (*b*) makes it convenient to define the ratio of the masses of two bodies as the inverse ratio of the accelerations produced by a given force, because this ratio is the same for all forces.

MEASUREMENT VERSUS UNDERSTANDING

FORTY or fifty years ago, after the system of electric and magnetic measurements had been fully established, every physicist had come near to a belief which was voiced by Sir William Thomson when he said that "when you can measure a thing you know all about it," and this point of view reached its climax in the days when physicists almost without exception believed that all subsequent development in their science would be to add significant figures farther and farther to the right of the decimal point! This point of view has, however, been swept away by the discoveries of recent years, and yet its germ seems to cling to some of the older phases of natural philosophy, for it comes to life in nearly every one's mind when any of the long-established principles of physics are contemplated. This is illustrated by nearly everything that has been said of recent years concerning the laws of motion. The measurement of force and the measurement of mass seem to be mixed up inextricably with the experimental aspects of the laws of motion in nearly every one's mind, whereas, as it seems to us, the laws of motion appear in their simplest and most clearly intelligible form when forces and masses (bodies) are not measured but merely identified. Sir William Thomson's statement certainly represents an obsolete point of view, which no doubt Lord Kelvin would have admitted. You can know a lot about a thing even if you can't measure it, and if you can and *do* measure it under widely varying conditions you can find out a great deal more about it. But to be able to measure a thing is, in the last analysis, merely to have enough wit to read a clock, or a yard stick, or to use a balance.

Measurement versus understanding! It certainly does seem fair so to characterize the difference between the natural philosophy of forty years ago and the natural philosophy of to-day; and no one shows a keener insight into the changing point of view than Karl Pearson[1] when he insists that after all physics, like botany, is a descriptive science.

INERTIA AND MASS. THE ESSENCE OF MATHEMATICAL PHYSICS

THE inverse ratio of the accelerations produced in two bodies by a given force is spoken of above as the ratio of the masses of the two bodies. Let us speak of this as the *ratio of inertias,* and let us reserve the word *mass* to designate the result obtained by weighing a body on a balance. Then the quantitative identity of mass and inertia is a discovery, but it is by no means a discovery which should make us ashamed of the balance as an instrument of precision.

Let us retain as the fundamental meaning of the word mass *the result of weighing on a balance scale.* Indeed, the laboratory man would laugh at any one who pretended to do otherwise; beware of the laugh of the laboratory man, *he* can satisfy the man from Missouri!

Yes, but the ratio of inertias is a more absolute thing than the ratio of masses because the balance must be on earth! But is it? No one can imagine a celestial operation which would show the ratio of inertias of two lone bodies without a third body of some kind acting.

[1] See Pearson's "Grammar of Science."

Then why object to the earth as a third body? We, for our part, thank the Lord for the Earth! We are satisfied with it!

Yes, but the balance compares the forces with which the earth pulls on two bodies—the weights of the two bodies. Very true, but just here is involved the one thing above all others which makes physics a mathematical science, and it is a thing which many of our mathematicians seem to think least about, namely, the establishment of invariant one-to-one correspondences by experimental tests. Use a balance on a batch of sugar and you get always and everywhere the same numerical result,[1] use it on a part of the batch and you get a different result. This is the only condition that is necessary to justify the use of the result as a measure of quantity of sugar. The purely arithmetical condition that ten units of sugar break up into a batch of seven units, and a batch of three units might also seem to be a necessary condition, but it is not necessary, but only convenient, in that it leads to a simple system of sugar-arithmetic.[2]

[1] This statement is somewhat idealized for the sake of simplicity. If the use of the balance did always lead to invariant results, the rational theory of the balance would be of interest to the balance maker and to the speculative philosopher, but it would be of no consequence whatever to the experimental or mathematical physicist. As things stand, however, the rational theory of the balance is of importance in the elimination of what we call systematic errors, for under ordinary conditions the balance does not lead to invariant results. Many such cases arise in physics, and it is the common practise to keep clear of such complications in the earlier stages of the development of physical theory by framing definitions on the basis of ideal conditions.

[2] As an example of the kind of thing here referred to let us agree to measure "amperes" by the number of units of heat generated in a given wire per second. Then 3 "amperes" from one branch of a circuit joining with 2 "amperes" from another branch would give 11.9 "amperes" in the main circuit. In this system the arithmetical form of Kirchhoff's law would be as follows: The current in the main circuit is equal to the square of the sum of the square roots of the currents in the various branches of the circuit. Similarly sugar could be easily measured so that you would pay 5 cents for one unit, 7 cents for two units, 8.65 cents for three units, and so forth, without making the serious mistake of giving your sugar at a cheaper rate to the wealthy man who gets more than he needs than to the poor man who needs more than he gets. Figure it out for yourself.

We respect the experience of two thousand years in that we base our definition of mass on the use of the balance; and we look at the identity of inertia ratio and mass ratio as a discovery, but we refuse to depart from the point of view of men who buy flour and sugar by the pound. We are not ashamed of the balance!

We also respect the broader view of mathematics as the logic of fixed relations in our acceptance of experimentally established one-to-one correspondences as the essential basis of mathematical physics rather than the mere readings of numbers on sets of weights, and yard sticks and clock faces!

W. S. Franklin,
Barry MacNutt

POWDERY SCAB OF POTATOES IN OREGON

The occurrence of the *Spongospora* scab disease of potatoes in Tillamook County, Oregon, has recently come to the attention of the department of plant pathology of the Oregon Experiment Station, and since this important trouble has apparently not been reported west of the Rocky Mountains the record may be of general interest.[1]

The lot of potatoes in which the disease was first found was raised on a farm in the rather isolated coast district of Oregon referred to above. The owner stated that the seed of this variety had been introduced from twelve to fifteen years ago from an eastern state and that new seed had not been introduced on his farm since that time.

The diseased tubers first found came from a lot that had been shipped to the writer for experimental study, this particular lot being badly affected with an internal browning apparently of non-parasitic origin and with the

[1] Since the above was written a record of the appearance of this disease in Seattle on potatoes from British Columbia has been reported.

Verticillium wilt. The variety was characteristically rough and the powdery scab pustules were not easily detected; in fact only one specimen was noticed at the time the tubers were being cut when examination was made for the other trouble. This specimen was laid aside and examination was not made for several days, when the identity of the disease was established, April 26, 1915. On reexamination several other specimens were found in this lot.

A rather hasty survey of Tillamook County was made at once (May 3–8, 1915) and, except on the farm from which the specimens above noted had been sent, only one specimen was found. This specimen was picked up in a grocery store in Tillamook with no possible chance of tracing it to the grower. At the farm from which the first lot was received about two dozen specimens were found on examining about three bushels of potatoes.

The fact that the district is isolated and that potatoes are not raised in sufficient quantity for export possibly has been a natural means of preventing a more general dissemination of the disease.

F. D. BAILEY

AGRICULTURAL EXPERIMENT STATION,
CORVALLIS, OREGON,
July 10, 1915

SCIENTIFIC BOOKS

Spencer Fullerton Baird. A Biography. Including selections from his correspondence with Audubon, Agassiz, Dana and others. By WILLIAM HEALEY DALL, A.M., D.Sc. J. B. Lippincott Company. 1915. 8vo, 462 pages, 19 plates.

Dr. Dall has conferred a distinct and lasting benefit on American science and letters by his presentation of the life of one of America's most eminent and beloved men of science. In the twenty-eight years that have elapsed since death terminated the career of Spencer Fullerton Baird, his fame has not diminished, the respect in which he was held as a man and scientist has not abated, and his example has been an inspiration to thousands. For no previous biography has anything approaching completeness been claimed; and it is safe to say that posterity will demand nothing more than is herein contained, for no subsequent biographer will have access to any essential facts or data that were not available to and utilized by Dr. Dall. Chief among the sources of information were Professor Baird's journal, extending, with certain breaks, from 1838 to 1887; letters selected by his daughter, which for the period prior to 1865 are mostly from his correspondents, as the official archives and Baird's own official letters were destroyed in the burning of the Smithsonian building in that year; reminiscences written from Miss Baird's dictation; and a mass of miscellaneous documents and notes that had been collected by Mr. Herbert A. Gill, who for many years had been associated with Professor Baird in the work of the Fish Commission.

The volume is with great propriety dedicated "To the memory of a devoted daughter, Lucy Hunter Baird," the only child of Professor Baird. It was she who began the collection of material on which she intended to base a memoir of her father; and it was she who, finding that she would be unable to complete that task, devised her own and her father's papers to the executor of her will with the request that the "memoir be completed by a suitable and competent person."

The task and the honor of writing a biography of Professor Baird could have been entrusted to no person more competent and sympathetic than Dr. Dall, who, as stated in his preface, had known Professor Baird since 1862, had had the benefit of his teaching and example from 1865 to the time of his death, had enjoyed the hospitality of the Baird home, and from 1869 had knowledge, at the time of its occurrence, of much that is recorded in the biography.

The biographer makes no attempt to enumerate or analyze Professor Baird's voluminous publications, which have already been covered by Professor G. Brown Goode's exhaustive bibliography. The author's "chief aim has been to show the man as he lived and worked; with glimpses of his relations to his contemporaries, to the promotion of science, and to great, and as yet hardly appreciated, public services."

The genealogical and family notes with which the memoir opens are followed by chapters on Childhood and Youth; Life at Carlisle; The Young Professor; The Smithsonian Institution; Life in Washington; 1850 to 1865; 1865 to 1878; The Secretary, 1878 to 1887; The U. S. National Museum; The U. S. Commission of Fish and Fisheries; and Appreciations.

The following epitome covers the principal events in the life of Spencer Fullerton Baird: He was born in Reading, Pa., February 3, 1823. His father died in 1833, and his mother then moved to Carlisle, Pa., where in 1835 he attended the grammar school, an adjunct of Dickinson College. In 1836, at the age of thirteen, he entered that college, of which his father had been a member of the academic senate and his two brothers were already students. After receiving the degree of A.B. in 1840, he began the study of medicine, and in 1841 and 1842 attended lectures at Bellevue Hospital, New York. This subject proving distasteful, he returned to Carlisle in 1842, and resumed his academic studies, taking the degree of A.M. in 1843. In 1845 he was made honorary professor of natural history at Dickinson, and in the following year became full professor, a position held until 1850. His salary, which at the outset was $400 a year, was increased to $650 at the end of the first term and to $1,000 in 1848. The first named salary being regarded as sufficient "to make a start," he married Miss Mary Helen Churchill, of Carlisle, on the strength of his professional appointment. In 1850, following letters written in his behalf by Audubon, Marsh, Dana and Agassiz, and on the nomination of Professor Joseph Henry, Baird, at the age of twenty-seven years, was elected assistant secretary of the Smithsonian Institution. This position was held until the death of Professor Henry in 1878, when Baird was immediately and unanimously chosen as his successor by the board of regents. Meanwhile in 1871, the position of commissioner of fish and fisheries had been created and Baird was appointed thereto by the President. On Baird's presentation of the need for and value of a suitable despository for the government collections, Congress in 1879 appropriated money for a fireproof building for that purpose, and Baird became the ex-officio director of the National Museum. The three positions—secretary, commissioner and director—were held until his death in 1887.

At a very early age Baird evinced a predilection for natural history that was to shape his career and make him one of the greatest systematic and economic biologists that has ever lived. The part of the work which gives the best insight into his early aims, ambitions, traits and habits of thought, as well as into his later plans, methods and aspirations, is the verbatim correspondence between Baird, the members of his family, and scientific and public men. These letters number about 225, and extend from 1831 to 1887. Especially interesting is the intimate correspondence between Baird and Audubon which began in 1840, when the young naturalist ventured to write the most distinguished ornithologist of the United States regarding two flycatchers he could not identify, and continued actively for more than seven years.

This and other correspondence show that Baird's capacity for making and retaining worth-while friendships was due to his zeal, candor and accurate knowledge of his subject, combined with great modesty and a dignified manner. Among the prominent scientific men with whom he became acquainted while still in his teens were, in addition to Audubon, George N. Lawrence, James De Kay, J. P. Giraud, John Torrey, Thomas Nuttall, Samuel G. Morton, T. A. Conrad, James D. Dana, John Cassin, Titian R. Peale and Isaac Lea. This acquaintance and association undoubtedly influenced and strengthened the trend of Baird's studies, which, before his twenty-fifth year, were confirmed and broadened by intercourse with John and Joseph Le Conte, Joseph Leidy, Thomas M. Brewer, Amos Binney, Oliver Wendell Holmes, Asa Gray, A. A. Gould, D. H. Storer, the Sillimans, James Hall, Sir Charles Lyell, George P. Marsh, J. P. Kirtland, Joseph Henry and Louis Agassiz. Especially noteworthy are the series

of letters reproduced in the memoir passing between Baird and Louis Agassiz, James D. Dana, George P. Marsh and Joseph Henry.

The early interest which Baird manifested in fishes increased with age and ultimately was responsible for the genesis and organization of the federal fishery service with which his name is ineffaceably associated. In 1848 specimens of the fishes from his collection were sent to Louis Agassiz, and arrangements had been made for a joint work on American fishes; this, however, owing to Agassiz's more pressing projects, never materialized and, after a few years, was abandoned by mutual consent. In 1854 we find Baird spending a summer vacation on the New Jersey coast and making there a collection of fishes which served as a basis for a noteworthy report. As early as 1863 Baird visited Woods Hole, Mass., and was impressed with the richness of the local marine fauna, and during the next few years he became greatly interested in the fisheries of the Atlantic coast and realized the need for a comprehensive investigation of the causes underlying the reported decrease of certain fishes. A comparison between conditions found in southern New England waters in 1863 and during a visit in 1870 strengthened his desire for authoritative investigation which would supplement the inquiries that had been undertaken by the various states. The psychological time having arrived; Baird having submitted a plan to Congress; the American Fish Culture Association having espoused the idea of federal aid to the fisheries; and state and national legislators, the general public and the fishery interests being in accord, Congress in February, 1871, passed a joint resolution drawn up by Professor Baird and Senator George F. Edmunds which made provision for a commissioner of fish and fisheries and for investigations to be conducted under his direction. President Grant did the obvious thing in appointing Baird to the newly created office, and there were thus imposed on an already busy man additional duties and responsibilities which yearly became more onerous and pressing and ultimately claimed a large proportion of his attention and time.

In 1871 Woods Hole became the headquarters of the commission, and then and there were laid the foundations of the first permanent marine laboratory in America. While the investigations were still in their incipiency, Baird formed the plan of inviting zoological students to visit Woods Hole to avail themselves of the large amount of material daily brought in that did not bear directly on the work of the commission, and he arranged for table and other facilities and cheap board. Thereafter Baird regularly spent his summers on the New England coast directing the local investigations while administering the business affairs of an organization that yearly acquired new functions and extended its activities into new regions. Woods Hole was the scene of his principal activities as it was the spot of his warmest regard. It was there that, advised and aided by men like George Brown Goode, Jerome H. Kidder, Theodore Gill, Richard Rathbun, Z. L. Tanner, H. C. Chester, A. E. Verrill, Alpheus Hyatt, W. G. Farlow, John A. Ryder and Sydney Smith, he planned and inaugurated those noteworthy biological, fishery and fish-cultural operations which soon brought the United States into the forefront of the nations in all such matters.

Long-continued overwork, more particularly that imposed by his unsalaried services as fish commissioner, began to tell on Professor Baird's strength, and in 1885 his cares were aggravated by unscrupulous newspaper attacks on the activities and personnel of various scientific bureaus of the government, including the fish commission. In July, 1886, after consultation with Dr. Weir Mitchell and Dr. William Osler, he went to Woods Hole, and remained there until late October. Fully aware of his physical condition, he presented his case to the board of regents at the 1887 meeting, and made arrangements for the election of his successor as secretary of the Smithsonian Institution. In July, 1887, he again went to Woods Hole; and there, "the scene of his hardest labors and most striking economic successes," the place that typified that governmental bureau in which he took such pride and which

was peculiarly his own in conception and organization, he died on August 19, 1887.

In selecting material for the chapter on Appreciations from the large assortment of available data, Dr. Dall has exercised admirable discrimination. It may not be inappropriate to quote therefrom an extract from a biographical memoir presented to the National Academy of Sciences by Dr. John S. Billings in 1889:

"The two men who have exerted the strongest influence upon natural history studies in this country are Louis Agassiz and Professor Baird. In many respects they were very unlike; circumstances gave them widely different fields, and they worked on different plans and by different methods. They began their public career in this country almost together; but Agassiz was already famous, as the result of seventeen years' work, while Baird was an almost unknown youth. Agassiz was a born teacher, a fascinating lecturer, gifted with eloquence which won its way everywhere; Baird could only speak freely in the presence of a few, and for the most part taught only by the pen and by example. Each of them created a great museum in spite of many obstacles, the first winning the means largely from private contributions, which were a tribute to his eloquence; the second gaining his end more indirectly, through his connection with the Smithsonian Institution and the government. Each of them gathered around him young men who were stimulated and encouraged by his example, who followed his methods, have continued his work, and have taught others, so that there are now observers and workers almost everywhere. The first made great use of the microscope and of embryology; the second very little, for he had to use the material available. The first had a vivid imagination which led him to frame many theories and hypotheses to be verified or disproved by future investigation and research; the second classified the facts before him, but theorized very little. Professor Baird's career as an original investigator was hampered and finally stopped by his administrative work, but in proportion as this latter increased he was able to furnish materials and opportunities for others. The pupils of Agassiz and Baird are the working naturalists of to-day and the teachers of those who are to come, and the two methods of study are being combined and developed to produce results of which we already have good reason to be proud, and the end of which no man can see.

"Upon the roll of the illustrious dead of the National Academy of Sciences his name stands out as that of a scientific man of high attainments, uniform purpose and indomitable energy, whose work has already added to the comfort and pleasure of hundreds of thousands of his fellow men, and bids fair to be a most important factor in supplying the necessities of millions yet unborn."

The merit, the charm, the permanent literary and historical value of this noteworthy volume can not be told in a review such as this. The work is no mere formal biography. It is a sympathetic analysis of the aspirations and labors of one friend by another; it is an appreciation of the work of one scientist by another; it is a simple, dignified, forceful narrative by one whose personal knowledge of the man and his times gave him a right to supplement the statement of facts with authoritative comment and criticism.

To those who knew Professor Baird, the volume of Dr. Dall comes as a delightful memento. To those contemporaries who had no personal acquaintance with him, it serves as a faithful record of one whose name and work are well known to all. To the generation that has come into being and reached maturity since Professor Baird's death, it is a fascinating history and an inspiring revelation.

Hugh M. Smith

Woods Hole, Mass.,
August, 1915

Chemical Technology and Analysis of Oils, Fats and Waxes. By Dr. J. Lewkowitsch. Edited by George H. Warburton. Fifth edition, entirely rewritten and enlarged. Volume III. New York and London, Macmillan and Co., Ltd. 1915. Pp. 483. Price, $6.50.

This volume deals with the technology and industries of the products named, and their analysis, also with the testing of lubricating oils and greases, soaps, glycerine and candles. A very important chapter is that on the waste oils, fats and waxes, and the products derived therefrom.

The reviewer knows of no treatise which deals so thoroughly with this phase of the subject. The contents have been increased by about twenty per cent., the principal additions being made in the sections upon the examination of butter, hydrogenated fats, varnishes, candles and soap. The work is encyclopedic, no omissions being noted, and indispensable to those having to deal with these compounds, or industries, which are among the most important. The reviewer would again take the opportunity to urge the inclusion of an index in each volume, as much increasing its consulting value.

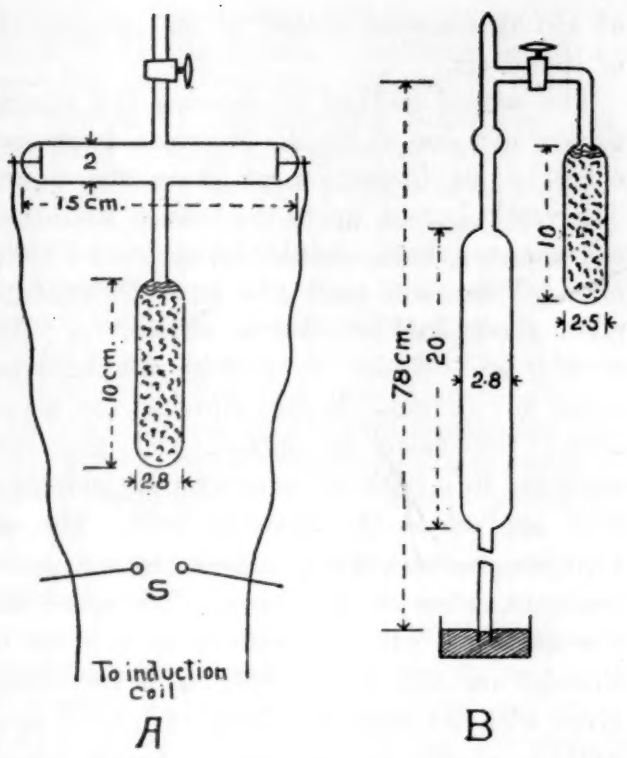
A. H. GILL

SPECIAL ARTICLES

THE ABSORPTION OF AIR BY CHARCOAL COOLED TO THE TEMPERATURE OF LIQUID AIR

THE remarkable absorption of certain gases by charcoal cooled to the temperature of liquid air, first pointed out by Ramsay and Soddy, may be exhibited conveniently by either of two simple pieces of apparatus. The first (*A* in the figure) makes use of the electric discharge as an index of the degree of absorption; while the second (*B* in the figure) indicates the absorption by the barometric column supported in a vertical tube dipping into a bath of mercury.

The general form and dimensions of the discharge-tube and its attached charcoal bulb are indicated in *A*. The volume of the charcoal used should be approximately equal to that of the discharge tube proper. A vent closed by a valve is included. For the experiment to be in its best form the cocoanut charcoal should be freshly burned, and to prevent undue absorption of air when not in use the tube should be partially pumped out and the valve closed. The connections are made as



shown in the figure, in which *S* is an alternative spark gap of about one centimeter length in parallel with the discharge tube. Any induction coil about the laboratory will answer. To operate, open the valve, then close it tightly, thus allowing the pressure within the tube to become atmospheric. On starting the induction coil the spark will pass at *S*. Now gently submerge the charcoal bulb in liquid air. In about one minute the spark at *S* will begin to weaken and a stringy discharge will appear between the electrodes of the discharge tube. Soon the spark at *S* will cease while the tube will be filled with the characteristic Geissler tube glow. In about four minutes the walls of the discharge tube will begin to flouresce, due to the bombardment of cathode rays. The intensity of this fluorescence will rapidly increase and soon the entire tube will be uniformly filled with a beautiful apple-green color. In about one minute more, five minutes from the start, the greenish color will begin to fade and sparking will *reappear* at *S*, showing that the vacuum in the tube is becoming "hard." In short the pressure may thus be reduced from atmospheric to about .001 mm. mercury in five or six minutes with no other agency than that of the absorption

of air by charcoal cooled to the temperature of liquid air.

The second method of showing the absorption of air, due to Dr. L. T. Jones, is at once clear by an inspection of *B* in the figure. The vertical stem, up to the branch leading to the charcoal bulb, should be at least 78 cm. long. This stem may also have an enlargement about half way up as shown. A valve should be included to protect the charcoal when not in use. Before starting the experiment the valve is opened and the tube mounted in a bath of mercury. Liquid air is then applied to the charcoal bulb. The absorption proceeds slowly at first, but soon gains headway as the charcoal cools. The speed that the mercury column acquires as it rises up through and fills the enlargement is surprising. Even with the ratio of volume of tube to charcoal as shown in the figure (approximately 4:1) the mercury column will mount to nearly full atmospheric pressure in the short space of five or six minutes.

Added interest is to perform the two experiments simultaneously.

Chas. T. Knipp

Laboratory of Physics,
University of Illinois,
August, 1915

Occurrence of the Protozoan, Colacium Multoculata Kent, in Iowa

In making collections of *Daphnia,* and other Entomostraca, on October 31, 1914, the writer discovered a small pond near Iowa City, Iowa, which fairly teemed with *Daphnia* of a striking green color.

Examination of these specimens in the laboratory revealed the cause of the coloration to be myriads of individuals of the Protozoa bearing chromatophores and being attached to the surface of the *Daphnia* completely covering, not only the body proper, but even the appendages in many cases.

These Protozoa yielded themselves readily to identification as belonging to the genus *Colacium*—Flagellates closely related to *Euglena* but differing therefrom in one essential, among others, of having a sedentary attached stage as well as a free-swimming stage. In the sedentary stage the individual zooids are attached by pedicles to some object or, as is more often the case, to some other form of animal life.

Kent (1881) mentions, at the close of his discussion of the *Colacium,* a supplementary species for which he proposes the provisional name of *Colacium multoculata.* It is with his description of this species that the animals under the observation of the writer most favorably compare.

As with Kent the writer demonstrated a very short pedicle and in no case was more than a single individual found on one pedicle. There is a general tendency for the animal to assume a quadrate-elliptical form in outline both when free-swimming and fixed, with an occasional broadening near the distal end. The shape is subject to more or less continual change. The chromatophores are very large and seem to be distributed near the periphery of the cell. Kent describes the presence of from two to four red spots instead of the single one commonly present and from this character proposes the name of the species. By far the most of the specimens examined by the writer possessed but one spot, some half dozen individuals from the many showed from two to four as described. In as much as the differing specimens agreed in all other essential characters they were undoubtedly variations of the same species. The possession of a flagellum by the free-swimming form was amply demonstrated.

Edmondson in his treatise on the Protozoa of Iowa[1] includes *Colacium* in his key to genera but states that no species of this genus has been reported within the state. It is probable that other species closely related to the one forming the subject of this note may be added to the list of Iowa Protozoa.

D. M. Brumfiel

Laboratories of Animal Biology,
State University of Iowa

Spore Measurements

The usual way of giving measurements of spores as width by length in μ is clear and

[1] Davenport Academy of Sciences, 1906.

satisfactory when the dimensions do not vary too much and are fairly constant. Identification by a given description becomes difficult when either one or both dimensions vary between wide limits. The distinguishing dimensional features of the æciospores of a given species, for instance, are not determined by the lowest and highest values (*e. g.*, 15–26 by 22–41μ) that the spores may attain, but by the most common combinations of width and length measured; that is, by the standard values. The latter can not be expressed in averages, which will vary with the numerical basis used and with the personal factor in picking out the spores to be measured. The numerical basis in particular is a factor which has been almost totally neglected in descriptions. I propose to give, in all cases but those of very constant measurements, a formula containing the numerical basis, the extreme range of width and length and the most common combinations of width and length found. The formula in our example would read: (48) 15–26μ by 22–41μ (19–22 by 26–30μ). (48) is self-explanatory; it gives the numerical basis; that is, the number of spores measured. 15–26μ by 22–41μ are the extreme measurements of width and length. (19–22 by 26–30μ) are the standard values of width and length. These values are found by arranging all measurements in two progressive tables, one by widths, the other by lengths. It is then an easy matter to find the most common values.

In cases where misunderstandings may arise the formula can be given as follows: (48 measured) 15–26μ by 22–41μ (standard 19–22 by 26–30μ).

For all measurements of a simple nature the old formula can still be retained, although the numerical basis should in every case be given. The method is, of course, not confined in its usefulness and accuracy to spores alone.

E. P. MEINECKE

THE NORTH CAROLINA ACADEMY OF SCIENCE

THE North Carolina Academy of Science held its fourteenth annual meeting at Wake Forest College on Friday and Saturday, April 30 and May 1, 1915. The reading of papers began at 2:50 P.M. on Friday and continued until 5:30, at which time adjournment was had, followed by the annual meeting of the executive committee. At night Dean Charles E. Brewer, of Wake Forest College, made the academy welcome to the college. President J. J. Wolfe, of the academy, then delivered his presidential address, "The Status of the Theory of Descent." Next Professor John F. Lanneau delivered a lecture "The Cosmoid," illustrated by an apparatus of his own design; and Professor A. H. Patterson gave a short talk on "The Importance of Humidity in Health and the Arts" with a demonstration of an interesting form of humidifier of North Carolina manufacture.

The academy met in annual business meeting on Saturday morning. Reports of the secretary-treasurer and of the various committees were made and an invitation for the academy to hold its next annual meeting at the State Agricultural and Mechanical College was accepted. An interesting discussion on the matter of membership was held and it was resolved to try to bring into the academy in 1916 all the scientific people of the state. To this end a large and representative canvassing committee was appointed. Ten new members were elected, who bring up the total membership to date to 70.

The following officers were elected for 1915–16.

President—A. S. Wheeler, University of North Carolina, Chapel Hill.

Vice-president—W. A. Withers, State Agricultural and Mechanical College, West Raleigh.

Secretary-treasurer—E. W. Gudger, State Normal College, Greensboro.

Additional members executive committee—Z. P. Metcalf, State Agricultural and Mechanical College, West Raleigh; W. C. Coker, University of North Carolina, Chapel Hill; E. T. Miller, Trinity College, Durham.

At the close of the business meeting, the reading of papers was resumed and continued until 1:30 when the program was finished. The total attendance was 21 out of a membership of 70. There were 23 papers on the program, of which only three were read by title. Perhaps the most marked feature of the meeting was the considerable discussion which followed the reading of many of the papers. Including the presidential address, which will be published in the current number of the *Journal* of the Elisha Mitchell Scientific Society, the following papers were presented:

An Outline of Modern Work bearing on the Theory of Descent: J. J. Wolfe.

Previous to 1900 the evolutionary hypothesis stood practically as Darwin left it in 1859. During the intervening years a tremendous mass of facts accumulated which tend to support it, but on the other hand some weighty objections have also been offered. These were, however, apparently met by the mutation theory which appeared in 1901, but unfortunately it has latterly encountered even graver difficulties than Darwinism itself. Its critics, Jeffrey in particular, have brought forward very strong evidence tending to identify the phenomena of mutation with hybridization. If this criticism shall stand, mutation is robbed of any just claim to being an explanation of evolution.

On the other hand, the work of Johanssen and others appears to demonstrate that individual variations are not heritable and all that selection can achieve is to resolve a species into its component elements, the so-called "pure lines," and choose that pure line manifesting the character in question developed to its highest degree. It can not carry the development of this character one whit beyond the limit attained by the species as a whole.

Now, if mutation is but the reappearance of some recessive character, segregating out from a long and complex process of hybridization in accordance with Mendelian principles, as De Vries's critics seem to have rendered highly probable; and if variation in the Darwinian sense be non-heritable, as the pure line investigations appear to show, how has the transition from one species to another occurred? That this has repeatedly taken place would seem to be beyond intelligent doubt. For answer, so far as the author can see, we are limited to two views. We must either assume the inheritance of acquired characters, or that all characters were present in the primordial germ cell.

As regards the inheritance of acquired characters, much work has accumulated both for and against its acceptance. On the zoological side in particular experimentation tends to support the view that acquired characters are non-heritable, while on the botanical side the tendency is perhaps in the other direction. The germ tissues in plants are not as early set apart from the soma as in animals, and are not nourished in an environment so constant and so well protected from environmental effects. Perhaps these facts have some bearing on the question. Nevertheless, any such broad generalization found true for plants would also be true for animals, even if its operation could not be so easily and clearly observed.

The alternative hypothesis proposed by Bateson, that all characters were present in the primal organisms, while not a very satisfying view, finds a parallel in the development of the adult from the egg. The biological world is pretty well agreed that every important character manifest in the adult is represented in some way in the germ cell. If then the mature individual has arisen by differentiation and specialization from a single cell, manifestly it is not unthinkable to suppose that higher animals were likewise represented in the primordial protozoa.

With the evidence before us, conflicting as it is, it is clearly impossible at the present time to say how evolution has occurred, yet, if personal opinions are not out of place on an occasion of this kind, it may be said that the inheritance of environmental effects seems destined to play a more important part in the final solution of organic descent than is accorded it at the present time.

Desmotropy: Alvin S. Wheeler.

The first case of keto-enol isomerism among the phenols of the naphthalene series was recently reported by Willstaetter and Wheeler. Juglone, a dyestuff in green walnut shells, yields on reduction 1, 4, 8-trihydroxynaphthalene, melting at 152°. After once being melted it melts thereafter at 96°. Since this type of compounds is very sensitive to alkalies, weakly basic reagents as semicarbazine and phenylsemicarbazine were employed to detect the carbonyl group. The lower melting product was found to be the ketonic form. Some work, not yet published, on 1, 4, 5, 6-tetrahydroxynaphthalene reveals another case of this nature. Here, however, it has been impossible to separate the two forms, the compound melting at 154° responding readily to both enolic and ketonic reactions. Numerous isomerization methods fail to reveal another form. The application of Knorr's ferric chloride and Kurt Meyer's bromine method to approximate the relative amounts of the isomers present is not practicable to the above cases. Ferric chloride oxidizes the compounds to quinones while bromine enters the ring of either form.

The H-H Waterwheel and Pump for Farm Waterworks: T. F. Hickerson.

The Hutchison-Hickerson waterwheel and pump, recently invented by R. B. Hutchinson of Wilkinsburg, Pa., and T. F. Hickerson, of Chapel Hill, N. C., is a discovery of a new application of the

old principle of the overshot wheel in the design of a small easy running combination wheel and pump and stand (made in the factory complete for installation) to utilize the flow and fall of small brooks as power for operating continuously a pump which pushes pure spring water to higher elevations. The remarkable simplicity, adaptability and reliability of this machine brings it in direct competition with hydraulic rams, all of whose defects seem to be met satisfactorily by the wheel and pump. One dozen of these wheels and pumps have been introduced in North Carolina during the past year. Among these is one which delivers every day through a vertical height of 45 feet 500 gallons of spring water for a large farm home, where the power of the stream which operates the wheel is only 1/100 of a horse power.

On Leidy's Ouramœba and its Occurrence at Greensboro, N. C.: E. W. GUDGER.

In the fall of 1914 considerable numbers of large and active ouramœbas were found at Greensboro. The amœbas themselves and the locality in which they were found were described. Their activities both in feeding and moving were discussed, and it was noted that there was no reversal of polarity, the tail-feather-like mass of fungous hyphæ always remaining posterior. The history of this interesting organism was then reviewed, and the conclusion arrived at that ouramœba (tailed amœba) is nothing but an ordinary amœba which has ingested fungous spores which have germinated and formed a mass of mould hyphæ which project from the posterior end of the animal. The full paper will be published shortly.

Some Igneous Rocks of Mount Collier: JOHN E. SMITH.

Mount Collier is in Orange County, N. C., about five miles west of Chapel Hill. It is typical of those igneous monadnocks of the eastern Piedmont, most of which rise to a common level about 200 feet above the peneplain. It was formerly much higher and of greater extent: this is shown by the position of parts of the mountain that have been separated from it by erosion, also by the fact that Ball Mountain, in Davidson and Rowan counties, of similar rock and structure, has been cut by a river (Yadkin) which flows through it. That the upland level of the region is a peneplain is also proved by the presence of smooth, rounded quartz pebbles on this plain. The mountain consists chiefly of dark rhyolite which made its way upward along the contact between the ancient crystalline schists north of it and the granite on the south. On each of its slopes flow structure has been observed in the weathered rock and in many places where it is fresh. It is called Mount Collier in honor of Professor Collier Cobb, who, in 1892, was the first to recognize its igneous origin. (Specimens and structure sections were used in presenting the paper.)

Some Observations on the Red Cedar: H. R. TOTTEN.

Juniperus virginiana is probably the only one of the four eastern species of *Juniperus* growing in North Carolina. *Juniperus communis* has been credited to the state, but its presence is doubted. The male and female flowers of *Juniperus virginiana* are borne on separate trees. The time of flowering is dependent upon the climate and weather. The male trees begin blooming first and the return of cold weather may delay the female trees. In both the seasons 1914 and 1915 the male trees began blooming nearly six weeks before the female trees. The young "berry" is formed soon after pollination by the growth and fusion of the sporophylls about the ovule. Fertilization takes place about the middle of June. The seeds are matured in the first season. The species is very variable in color and habit of growth, varying in the neighborhood of Chapel Hill and Durham in color from a glaucous to a deep green, and in form from an open spreading tree to a close spreading tree and to a narrow columnar tree.

Seasonal Distribution of the Army Worm Moth at Raleigh, N. C.: C. S. BRIMLEY.

Gives the result of some observations on the abundance of the army worm moth (*Leucania unipuncta*) at Raleigh in 1914, determined by the number caught on a number of nights in a "sugar"-baited moth trap. The observations began in mid-August, 1914, and have continued to the present time, May 7, 1915. The full data will appear in the current number of the *Journal* of the Elisha Mitchell Scientific Society.

Significance of Gossypol in the Cotton Plant: F. E. CARRUTH.

Gossypol, $C_{13}H_{14}O_4$ (or possibly $C_{32}H_{34}O_{10}$) according to Marchlewski[1] appears to be a dihydric (ortho) phenol. It occurs in peculiar glands, "resin glands," in all parts of the cotton plant. Its physiological significance is not clear. The change in color of the cotton flower on aging is probably due to it. It is a yellow substance, dissolving in H_2SO_4 with a red color and oxidizing easily in alkaline solution with a deep blue color.

[1] *J. Prakt. Chem.*, 1899, 60, p. 80.

It is being studied in an endeavor to show that it is a respiration pigment or an anthocyanic substance, rather than an end-product of plant metabolism. An effort to elucidate its constitution is being made by the North Carolina Experiment Station.

Fly-parasites as a Factor in controlling Army-worm in North Carolina in 1914: F. Sherman.

The army-worm (*Heliophila unipuncta*) was destructive in many localities in North Carolina in 1914, attacking millet, grasses and grains. Tachina-flies were abundant and laid eggs on the worms. A lot of 534 army-worms was separated into groups according to number of eggs per worm, and rearings made. Worms without visible eggs matured less than 10 per cent. of moths. Of worms with fly-eggs less than 1 per cent. matured moths. Highest development of flies was from worms with 3 parasitic eggs each (32.81 per cent.), the rate consistently declining both below and above that point. On all worms collected, the average was 2.44 fly-eggs per worm, close to the desired optimum. Outbreaks were of short duration and there was no widespread damage by any later broods. A more detailed article covering this work will be found in *Journal of Economic Entomology* for April, 1915.

On the Myth of the Ship-holder, the Echeneis or Remora: E. W. Gudger.

A brief account was given of some of the data relating to this myth, which began about the time of Pliny the Elder and persisted until about 1660. The true explanation was given by Ekman in 1904 in his work on "dead water." Material and data are being collected for a series of papers giving accounts of and explaining the myth, describing the use of the remora as a living fish hook, and lastly, giving as fully as possible the natural history of the fish—the matter of chief interest being the origin of the sucking disk.

The Sexuality of the Filament of Spirogyra: Bert Cunningham.

The general opinion, as shown by Wood (1872), Wolle (1887), DeToni, Klebs (1896), Vines, Bennett and Murry, and Mottier (1904), is that the filaments contain cells of one sex. West (1904), basing his assertion upon Hassall (1845), states that cross conjugation is exceedingly rare in Conjugales. The writer found a *Spirogyra* which follows the general description of Quadrata, with the exception of reproduction. This frequently occurred as cross conjugation, the zygotes being in such a position that it could not possibly be a combination of lateral and scalariform conjugation. This occurrence would tend to prove that the filaments of some *Spirogyra* at least are truly bisexual, and that the transition from the bisexual to the unisexual occurred in the family of *Spirogyra*.

Abnormal Specimens of Taraxacum: S. W. Geiser.

This paper notes the occurrence of a clump of dandelions at a point 70 feet E.N.E. of the N.E. corner of Cox Hall, on the campus of Guilford College. Seven specimens showed well fasciation of the flower-stipes. The multiple-headed character was not so pronounced as noted by Kirsch ('09): only two or three stipes in each of the specimens were united. The flower heads were either slightly confluent or independent. At the point of collection, the soil was unusually infertile, and the occurrence suggests Nieuwland's ('09) conclusion that the abnormality is due to a physiological change due to unfavorable soil conditions, and to age. Bowditch ('09) has also noted fasciation of the dandelion (*T. off.*) in an unfavorable environment. Diligent search failed to find abnormal specimens outside of the local circumscribed area.

For the following papers no abstracts have been received.

"The Present Status of the Martian Controversy," by A. H. Patterson.

"Filose Phenomena in Pieces of Gonads of a *Cubomedusa*," by H. V. Wilson.

"More Fossil Plants from the Moncure Shales (32 specimens)," by Collier Cobb.

"Cow Pea Weevil," by Z. P. Metcalf.

"Gossypol, the Toxic Substance of Cottonseed Meal," by W. A. Withers and F. E. Carruth.

"The Influence of Salt Solution on the Development of the Frog Egg," by W. C. George.

"Experimental Alteration in the Direction of Growth of a Sponge," by H. V. Wilson.

"The Importance of Humidity in Health and the Arts (with demonstration of a new form of Humidifier of North Carolina Make)," by A. H. Patterson.

"Simplifying our Methods of Teaching Cell Division," by Z. P. Metcalf.

"Monadnocks and Metamorphism in the Cretaceous Peneplain," by Collier Cobb.

"The Origin of the do, re, mi Syllables for the Musical Scale," by A. H. Patterson.

"Notes on Geology of Smith's Island," by Collier Cobb.

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